How to Get Started in QRP

DAVE INGRAM, K4TWJ

The Newcomer's Guide to Low Power Communications

One of the challenges in ham radio is working stations with the least amount of transmitted power. This book tells how the "pros" do it!

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QRP

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Preface

This plain language and easy-to-understand book is your hands-on guide and personal invitation to join the fascinating world of low power operation—QRP. It is a world filled with ultra-compact rigs, battery powered transceivers, and the incomparable thrill of using very low power to communicate over the longest possible distance. QRP is infinitely more, however. It includes homebrewing simple projects, experimenting with antennas, operating awards, clubs, contests, nets, and, well, the story is so long it became . . . this book!

The lighthearted air of using small QRP rigs on-the-air is a sheer delight. The excitement increases tenfold when a rare DX station replies to your low power signal or you cross the thousand mile-per-watt marker. This is Amateur Radio supreme and —friends—it is absolutely terrific!

Whether you live in a big city or remote suburban area, you are never alone in QRP pursuits. An enthusiastic—and very friendly—group of fellow QRPers are always active and listening for you on the bands. In addition to informal weekend QSO parties, there are daily QRP nets where you can meet other low power enthusiasts and prove *less is best.* Yes, QRP is great, and this book is absolutely your most complete guide to enjoying the action!

The following chapters were written to ensure that you enjoy maximum QRP success right from the start. We begin by discussing various areas of QRP activity, then present numerous tried-and-proven methods for operating QRP. Following chapters overview commercially manufactured QRP gear and accessories, plus describe a lavish array of easily assembled projects and inexpensive wire antennas.

Closing chapters look at some clever applications of QRP for VHF/UHF use, plus outline several battery and natural power systems applicable to both low and high power setups. We aim to please everyone!

A sheer wealth of knowledge related to equipment, operating suggestions, Dxing, understanding the bands, signal propagation, and much much more is packed into

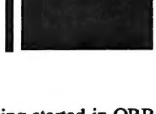
every page, so relax in a comfortable chair by a good light as we introduce you to the fascinating world of QRP.

Preparing a book of this magnitude was an extensive (yet exciting) endeavor, and we wish to recognize several outstanding individuals, groups, and companies for their assistance. Our thanks to Reverend George Dobbs, G3RJV, and the G-QRP Club; Paula Franke, WB9TBU; Bob Gaye, K2LGJ; Ed deBuvitz, W5TTE; and the QRP Club International (U.S.); and Tom Jurgens, KY8I; and the Michigan QRP Club. Thanks, also, to Ten-Tec, Yaesu, Icom, Kenwood, MFJ, Tejas, A & A Engineering, Bill Kelsey, N8ET, and Kanga Kits.

A very special and most deserved thanks go to my wife Sandy, WB4OEE, for assisting with this manuscript's preparations, drawings and typing: a mammoth chore. Finally, thanks to Don Stoner, W6TNS, of the National Amateur Radio Association, and representative Evelyn Garrison, WS7A, for their having encouraged me to write this book. Our efforts will be rewarded when you join QRP action and suddenly realize how very much of an exciting world of unlimited fun it really is!

73, Dave, K4TWJ

QRP Quickstart



Realizing that you purchased this book with the objective of getting started in QRP and that the shortest distance between two points is a straight line, this section presents a "short cut" guide for joining QRP action. Please understand this is not a summary of our book's contents, but rather an outline for getting started in QRP immediately. I will assume you are equipped with high enthusiasm, sufficient funds to make your dream an immediate reality, and that you'll will move at a fast rate. Then with no further ado, hang on: here's the Quick Start story.

Build Or Purchase A QRP Transceiver

Your choice. But remember that a preassembled and ready-to-use rig is ideal for immediately getting started in QRP! Units available in complete-kit form (right down to every necessary bolt and nut) are your next best choice, provided that you can afford to allocate sufficient time to promptly build the rig. Construction projects assembled "right from scratch" should be postponed until later, so as to keep your enthusiasm high. Pursuing an *invisible goal* can become disillusioning. If you presently own one of the many popular 100 watt transceivers, it can probably be reset to 2.5 or 5 watts output with a simple modification. Look in *Chapter 4* or check with the equipment's manufacturer for details.

Install A New (or refurbish your old!) Antenna System

Avoid the temptation to shortcut this vital step. Old antennas with aged coax and corroded connections can, and will most certainly, rob you of valuable milliwatts. Dipoles are inexpensive, easy to assemble, and work fine for lower bands. Inter-element connections on beams and verticals should be cleaned to *shiny new*, and this is absolutely the ideal time to replace that aging coax cable. If you use a vertical antenna, be sure it includes a good radial ground system and that radiation is not blocked by nearby buildings, foliage, etc.

Check And Correct Deficiencies

Tune/prune your antenna(s) for lowest SWR in your most often used operating range. Double check coax connectors to ensure that both center conductors and shields are well soldered. Place a wattmeter in line with your transceiver and double check output power.

Remove the wattmeter after completing the previous steps. Ideally, you want a single unbroken length of coax connected from the output socket on your transceiver right up to your antenna.

Brush Up On Your CW

QRP activity is popular on all modes, but it is most popular on CW. Practice copying weak stations as well as both fast and slow speed CW. After a short period, you will realize—or perhaps once again remember—that CW is actually fun, and you'll soon acquire the ability to copy call letters through heavy interference.

Hit The Airwaves With QRP!

Set your rig for 5-watts output, use full break-in so you can precisely time calls, and answer CQs from others rather than initiating your own CQs. Tune in the QRP net that meets on 7.030 KHz Tuesday evenings at 7:00 P.M. EST or 14.060 MHz Sundays at 6:00 P.M. EST. Listen close for the net control and callers: they will be weak, as everyone runs less than 5 watts. When the net control stands by for callers, check in! You have made your first two-way QRP QSO! If the net control (or another station you contact on the net) is over 1,000 miles from your QTH, you have also just qualified for the 1,000 mile-per-watt award. Check into the QRP net 24 more times, and you have qualified for yet another QRP award.

You are now off and rolling with QRP in high style. Continue expanding your horizons; the thrills become much greater in short order!

Chapter 1

The Fascinating World Of QRP

The world of QRP is an area as old and exciting as Amateur Radio itself. And yet, it's as new and refreshing as the latest model transceiver or any of the new and special frontiers of radio communications. QRP, the technique of using very low power for two-way communications, holds outstanding challenges and personal gratification unequaled by many other *specialized modes* of Amateur Radio operation. Visualize, for example, contacting over 100 countries while using a small coat pocket-sized transceiver. Or, imagine contacting Amateurs nationwide while using a transmitter the size of a postage stamp. Impossible? Indeed not: such feats are accomplished every day, by Amateurs just like you or I, while operating QRP.

The majority of QRP activity is conducted on the 80 through 10 meter (HF) Amateur bands, and involves working both in-country and DX stations while running five watts or less output power. The challenge is supreme but, as exemplified in *Figure 1-1*, the personal pride of achievement is absolutely beyond description!

After using low power for a few months, many QRP operators find additional challenges and enjoyment while using *less* than five watts output power. Others progress even further and pursue two-way communications while using mere milliwatts of RF energy on the HF bands. Favorable returns often convert *casual* QRPers into full time devotees! Linear amplifiers are soon ignored or traded as these with-gusto operators realize *it is not what you have, but how you use it.*

Amateurs accustomed to using 100 watts or higher power occasionally question the logic of using exceptionally low power levels. Why chance the guesswork and possible loss of a special contact when high power improves the odds? Why indeed, might one prefer traveling in a nimble sports car rather than a larger four door vehicle or why would a sportsman prefer big game hunting with a bow and arrow rather than a shotgun?

Figure 1-1—Ham heaven for sure! Author Dave Ingram, K4TWJ, with QRP gear and favorite QRP awards, including QRP DXCC Trophy #26. The vast number of operating achievement awards for QRP easily captivates one's interest for a full lifetime!

In addition to sharpening skills and improving operating techniques, QRP instills a high degree of pride and a sense of fair play on the bands. Communications take on real meaning rather than simply being statistics on a page. They produce factual results that the operator, rather than the rig, is what actually makes the difference! Many Amateurs spend an incredible amount of time proving that their rig works as expected (like working *easy DX* with 100 watts on the HF bands). Conversely, using QRP ensures that both the operator and his station are tops in efficiency and performance. Indeed, successful communications while using only a few watts of power is usually 30 percent rig and antenna effectiveness, 60 percent operator expertise, and 10 percent luck.

Want to sharpen your on-the-air operating skills, learn how to work DX like a champ, and be a top-notch operator under a wide variety of conditions? Start operating QRP! It's a blast of unlimited fun and excitement, that you can enjoy at home, while camping or vacationing, or even mobile. The small size and low battery currents required for QRP gear is especially appealing for on-the-spot outdoor operating. Indeed, such low power stations can be set up in many places where big rigs simply are not feasible! As *Figure 1-2* clearly shows, QRP outbackin' is in a class of its own!

The world of QRP is a homebrewer's haven. Inexpensive and simple design transmitters and transceivers can be home-assembled and used with very good results. A brief scan through recent monthly Amateur Radio magazines will usually produce

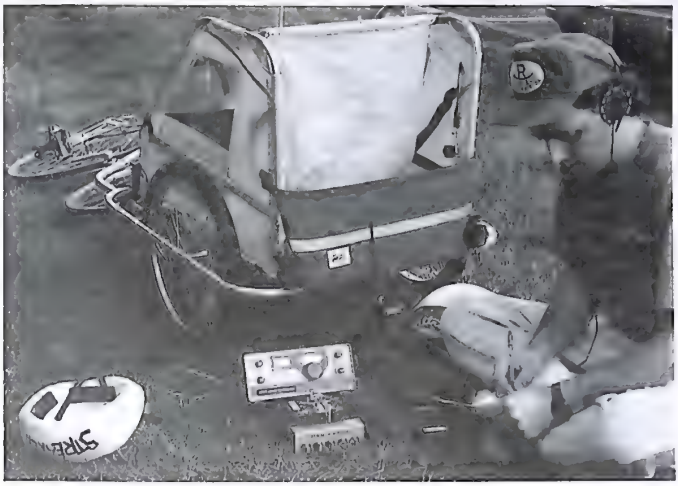


Figure 1-2—Lindel Thiesen, AA7DG, demonstrates the fun of operating QRP portable with all-battery powered equipment. The bicycle pulls Oregon-built "Burley" trailer that carries snacks, low band gear, keyer, wire antennas, FM handhelds, and extra batteries. While biking or camping, he stops at scenic points and makes a few prime-time QSOs. AS7DG has also bicycled to nearby Orchas Island and enjoyed his own IOTA EXpedition with the setup shown here. The thrill of operating QRP with only the sky as a canopy has to be experienced first-hand to be appreciated. It is terrific! Photo courtesy of AA7DG.

Figure 1-3—Imagine working the world with a little transceiver you can hold in your hand. Fantasy? Indeed not! The little 30-meter transceiver shown here has a built-in rechargeable battery and delivers approximately 2-watts output on 30-meters. The rig has contacted several countries, including Australia and Japan!

several appealing QRP circuits that can be built in only a few hours time. There is also a unique challenge in constructing the smallest transmitter and then using it to communicate over the longest possible distance.

The supreme challenge, however, involves constructing a complete transceiver small enough to fit in a shirt pocket. Working DX with a rig you can hold in your hand is simply fantastic. If you like designing your own gear, building small rigs, and operating in unusual locations, QRP is definitely the answer! One example of such a home-designed and assembled pocket transceiver is author K4TWJ's *Mini 30* transceiver shown in *Figure 1-3*. The cost? Approximately 40 dollars. The results? Thus far I have contacted over a dozen countries while using this little tyke in spare time (which is very limited at my QTH!).

Which bands are best for working QRP? That depends on your class of Amateur license. If you are a Novice or Technician Plus licensee, the CW subbands on 15 and 10 meters are your best bets. Voice/SSB operations on 10 meters are occasionally good for QRP operating, but competition with other new licensees and upper class Amateurs running higher power usually makes the going a bit rough. Alternately, Novice/Tech CW allocations on 15 and 10 meters are usually wide open with minimum QRM (interference). Experienced Amateurs may tell you that 40 meters is their favorite band for operating QRP, but the Novice/Tech portion of this band is quite crowded with newcomers (many using makeshift equipment and poor antennas), plus it is infested with foreign broadcasts heterodynes and howls at night. If you make contacts on 40 meters while using less than 5 watts, consider it a significant achievement! Frame the QSL!

If you hold a General or higher class license, operating CW QRP on the WARC bands of 30, 17, and 12 meters is very productive. In particular, 30 meters stands head and shoulders above all other HF bands in QRP appeal. The legal United States power limit on 30 meters is 200 watts, whereas the legal limit on all other HF bands is a whopping 1500 watts. Nearly all Amateurs use a barefoot 100 watt transmitter (often reduced to 50 or 60 watts output) and a basic dipole-type antenna for working 30 meters. A five-watt signal in this 100-watt world stands a significantly better chance than a 5-watt signal in a 1500-watt world. Seriously! Lots of Amateurs are having a ball on 30 meters while running only two watts.

I have also discovered that many Amateurs pay strict attention to testimonials of terrific DX (like working ZA/Albania while using only two watts) on 30 meters, but then attempt to achieve similar results on 40 meters. Fair enough; their reluctance to try 30 meters is to my advantage!

I must also emphasize that trying to work 30 meters with a multiband doublet, 40-meter dipole and tuner, or G5RV-type skywire is not the way to try 30 meters. In fact, such poor radiators for this particular band will very likely place your 100-watt transceiver in the equivalent of the QRP category! Your best bet is a simple dipole or full-wave Delta Loop cut specifically for 30-meter operation. Additional bands

with QRP appeal (and listed in order of preference) are 12 meters, 20 meters, 17, 10, and 15 meters. The 40-meter band, however, is a good QRP starting point at specific times when QRP nets are operational.

If you are an Extra Class licensee, the low end of 20 and 15 meters can prove quite fruitful. These CW ranges are not overly crowded, and operators are usually sharp. As a result, your success in QRP is usually good. Is all the QRP action on CW? Indeed not: it is just the best way to get through with low power. Voice/SSB QRP operations are also good on 10, 12, 15, and 20 meters when QRM is minimal (usually during weekdays rather than weekends). Remember, too, most SSB operators prefer armchair copy and an ever increasing number of SSB enthusiasts are adding high power amplifiers to their setup. If you receive one reply for every 10 or 20 stations called while using five watts or less, you are off to a good start on SSB QRPing. You will probably receive five replies for every 10 stations called on CW, however.

Work The World With QRP? You Bet!

It may seem astonishing that worldwide communications are possible while using less than 50 watts of power, yet that fact is proven almost daily on the Amateur HF bands. Consider, for example, the large number of 20 watt-limited Japanese licensees consistently working United States and other Amateurs around the world. If they can do it, so can you! Many British Amateurs have been serious QRP enthusiasts for years, and in fact, the **G-QRP Club** with its various and widespread array of activities, more than adequately supports their high levels of enthusiasm.

The United States boasts(?) one of the highest Amateur power level allocations in the world, yet we contact DX stations running substantially less power. Why then must we use such high RF levels, other than to compete with each other or unnecessarily feed our own egos? Quite clearly, high power is not always mandatory for long distance communications, but it can easily become a crutch. Look beyond that point, and you will see that low power signals experience little difficulty spanning the globe. The true QRPer is a *sharp listener* who possesses excellent operating skills rather than a blasting signal.

QRPers are on the bands (all of them) every day, but you must listen quite closely to hear them. Stated another way, the magic of QRP involves actually making those low power contacts. Each QRP QSL represents a proud achievement. Do not expect results comparable to using 100 watts while operating QRP with only two or three watts: that type of magic simply does not happen (at least not daily!). The magic of QRP can often be experienced by first developing and then maintaining international friendships. That is, talking with distant Amateurs on a semi-regular basis so they will recognize your call and signal when operating QRP.

While working on the station's main transceiver one evening, for example, author K4TWJ switched on a nearby QRP rig for casual listening and scanned the 10-meter band. A few Australian signals began coming in, and the challenge of contacting them while running QRP soon acquired priority over maintenance work. The first

Australian called reported my signal as 5 by 6, indicating the little QRP rig was doing a creditable job. As the contact ended, YJ8IR called K4TWJ to say hello and add another rare country to my QRP DXCC. Mavis' original call was VK3BIR; however, she was vacationing in New Hebrides and keeping an ear for friends she did not have time to notify before the mini-expedition. Not only was the contact spectacular, it created quite a stir of excitement and a large pileup following the QRP QSO (see *Figure 1-4*).

Try QRP Tonight!

Let's say your interest in QRP has been piqued and that you are ready to experience the thrills of low power-communications? Terrific! Assuming you presently have one of the popular Japanese-made transceivers with adjustable power output control, you can probably set the control for minimum and have an almost-ready QRP rig. I say almost because many of these transceivers only reduce output to 10 watts as factory supplied. A simple internal adjustment permits setting the control's minimum output to five watts (while maintaining 100 watts at maximum), but let's postpone that step until you are convinced *less is better*. We also need to review the overall efficiency of your station at this time. If you are having difficulty making contacts at the 100 watt level due to a poor antenna, old transmission line, etc., it definitely will not be easier at 10 (or five!) watts. Stated another way, your rig may be delivering 10 watts into the antenna's transmission line, yet radiating only a five-watt signal toward distant stations. Ah . . . this is where QRP expertise begins to shine. Take time to fine-tune your setup as we will soon discuss, and your first exposure to QRP will be a rollicking success. First, and most important, scrutinize your antenna system. If you have a dipole with tarnished and frayed wires, old balun and worn coax, replace the whole thing (always good advice whether QRP or QRO!). If you have a beam or vertical that was installed over three years ago, take it down and thoroughly clean all aluminum-joining sections. Pay close attention to the transmission line's feed point: if screw/clamps are anodized or corroded, replace them. Strive to make the antenna

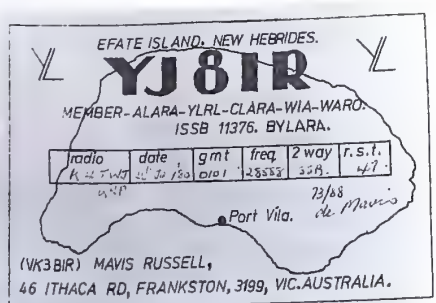


Figure 1-4—A prized QSL resulting from an unscheduled QRP contact with YJ8IR in New Hebrides. Maintaining international friendships has its rewards, especially among QRPers.

equal to, or better than new. Replacing the coax with a single and unbroken length of new low-loss cable (like RG8-X marine grade or RG213) is heartily encouraged. Remember to solder all coax connectors (PL-259s), particularly the shield at the connector's four holes. Finished? Double-check your work with an ohmmeter to ensure less than half an ohm of resistance, then scrape the PL-259s shiny clean with a pocket knife.

Another tip for radiating a good signal is to secure a good ground connection. Ground-mounted verticals require plenty of radials (minimum of 12: maximum of 120). If you are in a rush, the radials can simply be laid on top of the ground. Although some Amateurs will disagree, ground radials also improve the performance of Yagi or beam antennas. Ask yourself, for example, if the SWR changes as you rotate your beam in different directions, or if there is a difference when the ground is wet rather than dry. If the answer is oops, yes! to either of those questions, radials will prove very beneficial. Although regular bare wire is sufficient for radials, you will realize a definite advantage by using wide copper strap. Heavy-duty copper strapping like the type used by broadcast stations is expensive and difficult to work with, but thin copper foil like that shown in *Figure 1-5* does the same job at a much lower cost. This copper foil is available from Amateur dealers nationwide, such as Ham Radio Outlet. It may be purchased in 25 or 50-foot lengths. You can then cut the 3-inch wide strap down the middle to produce twice the length at half the width.

Okay: do you have your antenna system refurbished and ready for QRP action? Terrific! Hopefully, you will be trying QRP on 30 meters. Alternately, you may have selected 10 or 40 meters for the endeavor. If your transceiver has full break-in CW capabilities, use it. The ability to listen in between your transmitted dots and dashes will let you precisely time calls for best results. Strive to answer CQs from others rather than calling your own CQ. Finally, begin by calling a few in-country stations rather than going after DX. If you have a choice of stronger or weaker stations, the latter choice will probably prove more fruitful. Strong signal stations usually have

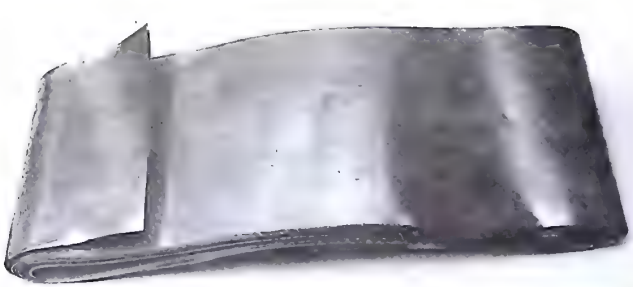


Figure 1-5—Like to get higher performance and better QRP results with your vertical antenna? Substituting thin copper foil like shown here for regular wire produces greater RF-surface area and noticeably improves signal radiation.

several callers: the weak guys listen closer for replies. Your best chances for success are during week nights, as more Amateurs take to the *airwaves* (and create more interference) during weekends.

Do not expect incredible results. An average of two or three contacts out of 9 or 10 calls within a 20 to 30 minute period should be considered exceptionally good. This is where a deluxe rig with dual VFOs and multiple memories is advantageous. Use them for storing stations you plan to call after they complete an in-progress QSO, then switch between stations/memories to work them *in rapid-fire order*. Now it is your turn: remember our previous note and go for it! Mark this place in the book, and we will continue after you have made a few "appetite whetting" QRP contacts.

Are you back? Were you surprised stations could actually copy your five or 10-watt signal? Honestly, your fine-tuned setup probably performed better than some stations using poor antennas and haphazard operating techniques. If one of your contacts compared S-meter readings between 100 watts and five or 10 watts, you probably noticed there was only a slight difference (typically S9 with 100 watts becomes S5 or S6 with five or 10 watts). Combine that fact with the high amplification factor and wide AGC range in modern transceivers, and the distant operator may have noticed only a bare drop in volume when you went QRP. How is that possible? Each doubling or halving of an RF power level increases or decreases your signal by 3dB, and each 3dB (plus or minus) equals one S-unit. A 100-watt signal decreased to 50 watts thus drops 3dB or one S-unit. Decreasing from 50 watts to 25 watts drops your signal another S-unit, etc. (see *Figure 1-6*).

One final point: for each 3dB of output power you relinquish, add 3dB in operating expertise. You can do this by precisely timing your calls, listening for lulls or holes in DX pileups (and putting your call into that spot only one time) and by being op-

Figure 1-6—The difference between 5 watts and 100-watt signals is often a mere four S-units and barely noticeable on modern transceivers. Can you discern variations of S5 and S9 signals without looking at your transceiver's meter?

erational on a band just as it opens to DX in the morning, or right as it begins to close (best DXing time) in the evening. Operating procedures and tips will be discussed further in the next chapter. Meanwhile, on with our overview of the world of QRP!

QRP, QRPp, and Milliwatting

The term QRP is a Q-code meaning "shall I reduce power to ____ watts or will you reduce power to _____ watts?" The term QRP has thus become a bit of Amateur Radio slang meaning *low power*; the definition of which is widely accepted as five-watts output. Many Amateurs (including your author) have achieved DXCC at this power level and have *started over*, striving for DXCC while running only one watt of power. This low-power level has become known as QRPp. DXCC with one watt? You bet! It is being done every day on our HF bands! Friends, we are talking about working 100 countries with a little homemade transmitter you can hold in the palm of your hand!

But there is more! The latest and hottest trend is milliwatting: communicating while using less than one watt of output power! Say what? Surely Dave jests! No way, friends! Milliwatting is big, and it is here to stay! Before writing that statement, I switched on my QRP transceiver this morning and made a couple of nonscheduled contacts while using only 500 milliwatts (one-half watt) of output power. My first contact from Alabama on 30 meters was a W7 in Washington state. My signal report was an impressive 569. I then switched to 17 meters (which was just opening for the morning and contacted a VK6 in western Australia. Looking back at the wattmeter, it indicated only .250 watts output (250 milliwatts). That is exciting results from any standpoint, and the resulting QSL (and 44,000 miles-per-watt award) shown in *Figure 1-7* occupy a very prominent position in my shack today. But wait: My milliwat-

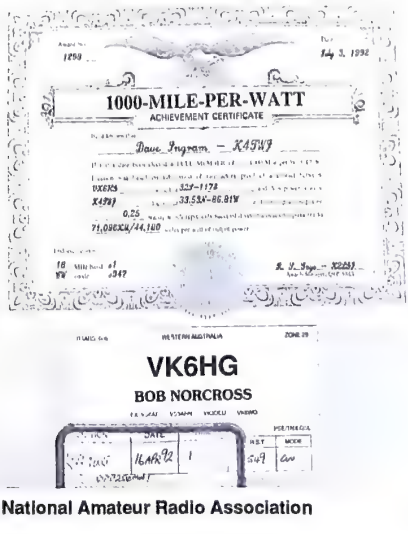


Figure 1-7—QRP Flash! While writing this chapter, we contacted VK6HG in western Australia while running only 250 mw. Shown here is the QSL (note 250mw in magnifying glass) and resultant award for 44,180 miles-per-watt contact. No doubt about it; milliwatting is hot and growing!

ting is only a tip of the iceberg!

Let's take a brief peek into the QRP log of Michael Czuhajewski, WA8MCQ, in Maryland for some real milliwatting. January 12, 1992: Worked WARPI in Minnesota on 10 meters while running 10 mW. Worked him again during Michigan QRP contest while running 1.69 mW on 15 meters for 558,000 miles-per-watt. January 18: Contacted NG1G in Vermont while running 9 mW: 43,000 miles per watt. January 19 copied WA1JXR's 9-mW signal (70,000 miles per watt). Is this not fantastic? There is more! WA8MCQ also worked WX7R on 10 meters while using 24 mW. He also called into the 40 meter QRP net while using 2 mW and exchanged signal report for 180,000 miles-per-watt. During the Michigan QRP contest, WA8MCQ ran an average power of 13.9 mW and made 20 contacts in 14 states on 40, 20, and 15 meters. During the ARRL 10-Meter Contest (amidst the big boys with high power), he ran an average power of 23 mW and made 22 contacts in 10 west coast states, plus France and England.

Are such reports once in a lifetime events? No: W9PNE made *Worked All States* while running only 50 mW. He is now pursuing WAS at 25 mW and is up to 40 states. Has that feat been topped? There are rumors of stations making contacts in the millions of miles per watt category, and several Amateurs have even claimed achieving a billion watt-per-mile QSOs. Obviously, when you consider these incredible results while using super low power, traditional five-watt QRP is like running a big rig! Now a final surprise: Several of the previously mentioned 10-meter contacts by WA8MCQ were achieved while using an indoor dipole in his attic! QRP, QRPp, and milliwatting are not pipe dreams at all. They are in fact reality!

Additional QRP Frontiers

QRP operations are not limited to the HF bands; they also include VHF, UHF, and microwaves. You have surely heard others talk about operating 2 meter FM while using a couple hundred milliwatts of power or Amateur Fast Scan TV activities, while using small transmitters mounted inside camcorders. These special areas are also related to QRP in several ways. Developing high RF levels at ultra high frequencies is difficult and expensive and, since these frequencies are essentially line of sight, high RF power levels are usually unnecessary for Amateur applications. High-gain antennas can be constructed for UHF/microwave frequencies much easier than for lower wavelengths, and large amounts of gain are more easily accomplished on these bands. Additional details concerning QRP on upper spectrum allocations are presented in another chapter in this book. Meanwhile, we invite you to keep an open mind and ponder the many opportunities available to today's QRP enthusiasts. This is an ever-expanding world, and there is no reason to confine your interests to only one small part of the overall action. Climb out of that rut and enjoy Amateur Radio to its fullest!

Shortwave listening and QRP operating can also be combined in some very interesting ways. Many times, for example, you can use a small QRP transmitter, like the one shown in *Figure 1-8*, with a shortwave receiver (the type with a built-in BFO).

Other times, you can enjoy SWLing and switch on the QRP transmitter when weak stations from distant lands start booming in.

An increasing number of Amateurs are also finding mobile QRP activities a blast, and have switched to this exciting subset of QRP'ing almost exclusively. This technique is most commendable—and it really works. Additionally, the low current demands on an auto's battery during long periods of parked operation do not create the old *dead battery syndrome.* I have been operating QRP mobile for over two years and lost count of the countries contacted after 25 or 30. Who keeps count? It's just one heck of a lot of fun. My good friend Brian Wingard, N4DKD, also runs QRP mobile and reports similar results.

Small low-power transceivers and modern autos with limited interior space and massive computer-control systems are a perfect combination. In fact, high power operations often play havoc with electronic fuel injection and cruise control systems, whereas QRP perks right along with no problems. During a recent quick jaunt to the beach in a rental car, I connected my QRP transceiver to the auto's cigarette lighter socket and snapped a simple seven foot antenna on the trunk. Operating 30 meters only, during two 30-minute periods, I contacted several European and Central

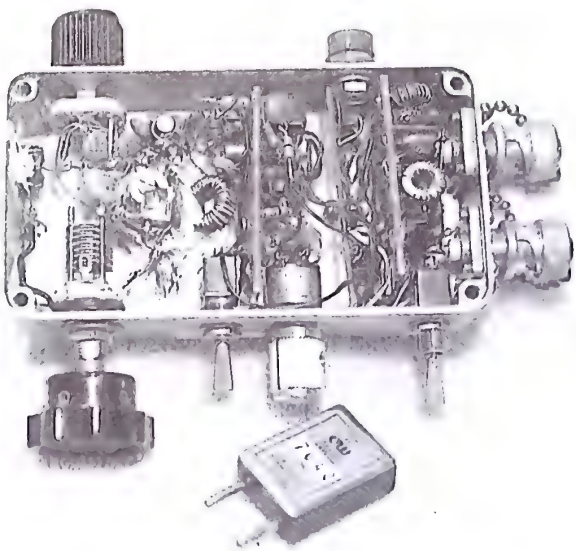


Figure 1-8—Small QRP transmitters like this pocket-sized unit built by Michael Czuhajewski, WA8MCQ, are great traveling companions, and they make a neat QRP station when combined with a small shortwave receiver. Photo courtesy of WA8MCQ.

American countries. After returning home, I received three letters from Amateurs working DX stations after I contacted them, and asking what I used to produce such a good signal, as well as what the exact call of the DX stations were, which they were unable to copy off-the-air.

The Serious, Casual, and Just For Fun QRPer

We often hear various Amateurs referred to as serious or casual DXers, but such general classifications of hams can also be applied to QRP enthusiasts. The serious QRPer, for example, is typically an Amateur that seldom (if ever) uses more than five watts. In many cases, this hearty soul has managed to attain WAS or DXCC, perhaps, and then—several years hence—moved in more challenging directions to recapture the romance of Amateur Radio.

The serious QRPer is a very sharp operator with an unusually well-tuned antenna system. This Amateur is quite often well known in QRP circles. He or she typically enters high-profile contests in the QRP category, as well as the low-key, less-frequented QRP mini-contests. They usually turn in very impressive and honest scores, again using equipment capable of no more than five-watts output. It is truly amazing to watch these pros in action: they pull signals right out of the noise and work stations on an almost continuous basis. Our hat is off to these gusto QRPers—they truly know how to enjoy Amateur Radio!

The casual QRPer mixes low and medium power operations as desired and often has a hundred-watt transceiver plus two or three QRP rigs for home and portable use. Most of us fall into this category and typically consider QRP operating as a fun expansion of our hobby. The casual QRPer typically uses a commercially manufactured or homebrewed low-power transceiver for occasional home use and as a portable rig for camping or vacation. He or she may purchase a QRP kit at a hamfest and assemble it as a strictly spare-time, and just-for-fun project. Occasionally, the casual QRPer may enter large contests in the QRP category. However, this Amateur's score usually reflects personal enjoyment and a lower number of contacts, more than an all-out effort. The casual QRPer can also be dubbed a *weekender*, as low power activities are often combined with brief outings and vacations while higher power is used for most *home station activities*. Such is the glamour of QRP—it blends well with every Amateur's interests and preferences.

The *just for fun* QRPer doesn't actually represent a category of operation, but rather my own example of how Amateurs of any license class can enjoy off-the-air fun with QRP. In this case, an Amateur home-assembles a small and simple transmitter like my *K4TWJ Pen* described in a following chapter. He might only use a 7-or-8-inch length of wire for an antenna, perhaps for demonstration purposes at a local club meeting or as part of a QRP forum that he's giving at a hamfest or convention. As an alternative, the *fun QRPer* may include a ridiculously simple receiver in his *pocket rig* package, and actually communicate with a friend's transceiver 50 or 75 feet away.

In other words, I am describing *simply for fun* projects that are not necessarily used on the air (although they can be attached to an antenna for real milliwatting fun) but rather pocket projects that anyone can enjoy on an impromptu basis. If you have not tried this aspect of QRP, incidentally, you are missing a real treat. It's something of a chuckle to stand near an operating transceiver—or even a receiver—at a hamfest or club, and then dial up the appropriate frequency on your pocket rig, and start calling CQ DX!

When an equally poor receiver is included in your package and you actually make contact with the operator standing only a few feet away, the surprise party really gets rolling! *Just for fun* QRP blends with serious and casual QRP activities alike, and we challenge you to add this extra level of enjoyment into your Amateur life. You'll absolutely love it!

Important Notes On QRP For New Licensees

Since I often feature QRP topics in my *CQ* magazine *World of Ideas* column, I receive many inquiries from new Amateurs concerning spotlighted circuits. In each case, the newcomer visualizes QRP as a way to initially get on the air at low cost. I understand your plight as I started out myself with a homemade transmitter built on a cigar box and a military surplus receiver purchased for only three dollars. But this is not the way to get started in Amateur Radio. You need all the positive encouragement you can muster at this most impressionable time. What you don't need are disappointments, and attempting to use QRP exclusively on Novice/Tech allocations of 40 meters is not, I repeat, **is not** the way to go! If you are honestly restricted with limited funds, enlist an Elmer's help in securing an older transceiver in good condition (and one capable of 100 watts output). Make some enjoyable contacts on-the-air and work some DX with your smooth operating rig, then consider adding a QRP rig for additional fun. Remember, low power operating can be quite challenging—and perhaps even frustrating—as making contacts with only a couple of watts is always more difficult than using 100 watts. Personally, I suggest the *just for fun* concept, previously described, for complimenting your home and/or portable setup. This approach lets you combine and enjoy all the fun of QRP and your own big home station. Rest assured that your upper-class licensed friends will be more than duly impressed by your first construction project during visits to your shack.

QRP During The Early Days of Amateur Radio QRP in the '20s and '30s was usually a matter of running five watts or Less—although there was really no intelligent way to measure the power. There was lots of DX—and plenty of poor antennas!

The Magic of QRP

Some Amateurs may unconsciously think that operating QRP represents something in the way of magic. Thus, they expect to achieve results comparable to (or better than!) those obtained when using a 100 watt rig with a good home antenna. **Friends, that simply is not the case!** The magic of QRP is much more accurately a combination of sharp operating skills, an excellent antenna, and actually making contacts with low power. There's nothing magical about that. Each successful QSO is a spe-

cial achievement and is often measured on a miles-per-watt basis. QRPers are active on the HF bands every day but, like the classic tale of Jason and the Argonauts, one must listen closely—often a couple of layers below normal signals—to find them. But this does not mean that all weak signals are being transmitted by official QRPers, of course. The fact is that many Amateurs are simply using regular transceivers and pumping 90 percent of their power into ineffective radiators. The so-called magic of QRP, then, actually results from obtaining the biggest results from the with lowest power levels!

QRP Groups and Clubs Around The World

QRP activities from United States Amateurs alone is really only representative of the tip of the iceberg; its popularity is even greater on other continents. British Amateurs, for example, have been heavily involved in lower power communications for many years. The **G-QRP Club** is the largest and most well known low power club in the world today. Its membership numbers over 5,000, and the club also manages to produce an exceptional monthly magazine, named *SPRAT* which is always loaded with terrific ideas and circuits for homebrewers.

The G-QRP Club also has a QSL bureau for contacts made between members, and a data service providing photocopies of circuits appearing in *SPRAT*. The club holds weekly activities on the air and some rather special contests, several times a year. These contests include the OK/G-QRP Weekend, QRP Winter Sports, the famous G-QRP Contest International, and much more. In addition, the club also holds its own mini-convention each October in Rochdale England, and usually joins the United States QRP groups at the annual Dayton Hamvention.

An impressive number of awards are available to G-QRP Club members. These awards are recognized worldwide and are always worth pursuing. A brief synopsis of G-QRP awards follows.

The **Worked G-QRP** award is available to members working 20 other members, while both stations are using QRP. Endorsements are available for each additional 20 member contacts.

The **QRP Countries** award is available for contacting 25 countries while using QRP. The other station is not required to use QRP for this award. Endorsements are available for each additional 25 countries contacted.

The **QRP Worked All Continents** award is available for contacting all six continents of the world while using QRP. Stations contacted are not required to use QRP.

The **QRP Masters** award is available to G-QRP members holding awards for contacting 60 other members, 75 countries, and 20 countries while both stations are using QRP.

Believe it or not, trophies can even be earned! Trophies are awarded as follows. The G2NJ trophy is awarded for outstanding service in international QRP. The Partridge trophy is awarded annually for the best antenna article appearing in *SPRAT*. The Suffolk trophy is awarded annually for the best nontechnical article appearing in *SPRAT* during that year. The G4DQP trophy is awarded annually to the member submitting the best log of QRP contacts made during the Winter Sport contest. The Chelmslay trophy is awarded annually for the best QRP log submitted within specific guidelines that include the use of a single element antenna not more than 35 feet above the ground and 132 feet in length.

Membership in the G-QRP Club is open to all Amateurs worldwide, and the cost (including subscription to *SPRAT*) is approximately 12 dollars per year. British Amateurs wishing to join the QRP Club should contact David Jackson, G4HYY, Castle Lodge West, Halifax Road, Todmorden, Lancs, OL14 5SQ England. United States Amateurs wishing to join the G-QRP Club contact Luke Dodds, W5HKA, 2852 Oak Forest, Grapevine, TX 76051.

Additional European-located QRP clubs include the **UA QRP Club** (Russia) whose membership is coordinated by Oleg Borodin, RV3GM, P.O. Box 229, Lipetsk 43, USSR. Include an SASE and three IRCs for information. There is also a very active **Czechoslovakian QRP Club** coordinated by P. Doudera, OK1CZ, UL Baterie #1, 16200, Praha 6, Czechoslovakia. (Include two or three IRCS with your SASE for information.) The **German QRP Club** is also quite active. This **DL AGCW QRP Club** is coordinated by Ha Jo Brandt, DJ1ZB, Lohensteinstrasse 78, 8 Munchen 60, Germany (two IRCs and SASE for information).

Although slightly above the formerly-established five watt level, the world's largest number of QRP operators are located in Japan. A separate license class authorizes both SSB and CW privileges with a maximum power of 20 watts. One only has to call CQ on 10 meters during a good band opening to realize the vast number of successful JA-QRP operators, not to mention exactly how such low power signals sound at the other end" (in the United StatesA.). **The JA QRP Club**'s coordinator is Taka Masuzawa, JH1HTK. Check the latest callbook for Taka's address and include two IRCs with your SASE when inquiring about this club.

Two outstanding and very active QRP clubs are located in the United States. We heartily encourage you to join both of these groups. First is the **QRP International Club (QRP ARCI)**, which also produces the outstanding *QRP Quarterly* newsletter. Lifetime membership in the QRP ARCI (and a yearly subscription to *QRP Quarterly*) is presently 12 dollars the first year and 10 dollars every year thereafter. To join, send your application to Mike Kilgore, KG5F, 2046 Ash Hill Road, Carrollton, TX 75007. The QRP ARCI was formed in 1961 and has grown quite rapidly since that time. The club sponsors several contests including Sprints, QSO parties, Homebrew on-the-air contests, and a milliwatting trophy presented in conjunction with Field Day.

Figure 1-9—Club-sponsored awards like the magnificent QRP ARCI certificates shown here add a special touch of excitement to low power communications. Our special thanks to K2LGJ and the QRP ARCI for sharing views of the sample awards.

Figure 1-10 Joining several QRP clubs will keep you abreast of the latest news and fill your mailbox with QRP fun. Try it! At the upper left are the ARCI publications, in the center is the famous Michigan QRP Club and to the right, SPRAT, from England.

Figure 1-11—Informal discussions and forums on QRP are always hot topics at hamfests and club meets. Rev. George Dobbs, G3RJV, drives home that point during this impromptu photo from a recent hamfest/rally. If you have an opportunity to attend any QRP forums, particularly those where George is speaking, go for them: you are sure to see some fascinating little rigs and acquire some good tips for opperating QRP.

The QRP ARCI always has a rather extensive awards program that includes QRP WAS, QRP WAC, DXCC/QRP, and an award for contacting 25 fellow QRP club members (see *Figure 1-9*). Information packets on the QRP ARCI Club are available by sending a one dollar service charge to Mike Bryce, WB8VGE, 2225 Mayflower, N.W., Massilon, OH 44647. Club members desiring more information on QRP contests can contact Red Reynolds, K5VOL, 835 Surryse Road, Lake Zurich, IL 60047. Club operations are handled by Paula Franke, WB9TBU, P. O. Box 873, Beecher, IL 60401. The QRP ARCI also has several QRP nets that meet on-the-air every week. Net activities are coordinated by Danny Gingell, K3TKS, 3052 Fairland Road, Silver Springs, MD 20904. If you really want to enjoy QRP in high style, join at least two clubs and let their bulletins and newsletters, such as those illustrated in *Figure 1-10*, help maintain your high enthusiasm for low power operating.

There are a number of organizations that support QRP activities in various ways, all designed to enhance the excitement (and your enjoyment!) of low power Amateur Radio operation. One of these organizations is the National Amateur Radio Association. While not exclusively a QRP organization, NARA has implemented a very interesting—and unusually flexible—awards program that offers the QRP enthusiast a wide variety of certificates and plaques. One of the more interesting NARA awards is the NARA QRP-25 Award (see Figure 1-13) which is available from NARA at P.O. Box 598, Redmond, WA 98073-0598. Write them for details.

NET	FREQUENCY	CONTROL & ALT.	DAY	TIME(GMT)
TCN*	14.060 kHz	W5LXS/W5TTE	Sunday	2300
SEB	7.030 kHz	K3TKS/KH6CP/1	Wednesday**	0001
GSN	3.560 kHz	W5LXS/W5XE	Thursday**	0100
GLN	3.560 kHz	K3JT/KH6CP/1	Thursday**	0100
NEN	7.040 kHz	WA1JXR/K3TKS	Saturday	1200
WSN	7.040 kHz	W6RCP	Saturday	1600

* On weekends of major contests, TCN will meet one hour later.
** Evening of the day before for United States and Canadians.

Figure 1-12—Present operating schedule of QRP ARCI nets. Discussion in text.

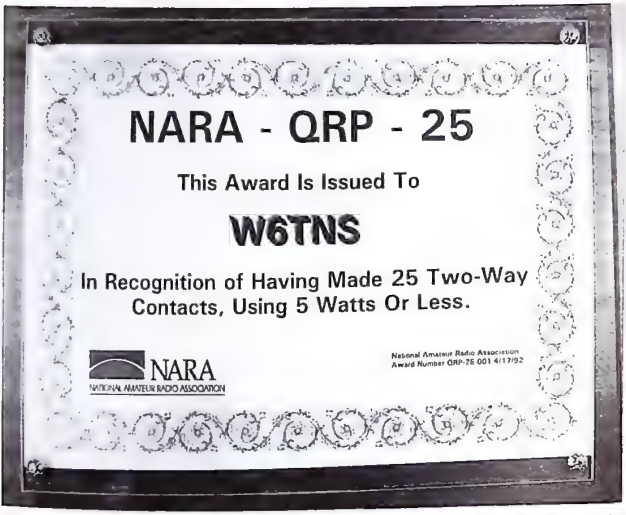


Figure 1-13—The NARA QRP-25 award is made to anyone who contacts 25 or more stations while using 5 watts or less. This is a plaque version of the award.

Another enthusiastic and active group is the **Michigan QRP Club** at P. O. Box 80804, Lansing, MI 48908-0804. This club also produces a quarterly newsletter, *The 5-Watter*, and membership in the Michigan QRP Club (which presently has slightly more than 1,000 members) is approximately six dollars. This club is very active in many aspects of QRP, and sponsors the Michigan QRP contest each winter, plus it jointly sponsors the classic QRP Sprint with QRP ARCI. I have followed their newsletter for several years, and it is very impressive.

Now, be sure to read on for some great proven secrets for successful QRP operating.

Chapter 2

The Fine Art Of Operating QRP

As most QRP enthusiasts heartily agree, operating with low power is an absolute barrel of fun and enjoyment. This does not mean, however, one can grab a four or five-watt crystal-controlled transmitter, pocketsize receiver, hank of wire, and take to the airwaves with a high degree of success. Such tactics seldom prove fruitful with 100-watt setups, so they are obviously extreme handicaps for working QRP. Approached in a slightly different manner, the QRP enthusiast will realize good results amidst higher power signals on the bands.

This chapter will present a number of tried and proven operating techniques and DXing secrets which are directly applicable to all Amateur Radio activities, and especially QRP. Understanding and utilizing these concepts will put you head and shoulders above the competition, allowing you to be justifiably proud of your accomplishments. I am quite serious in these statements and I have the "track record" to prove it. Using tips and ideas presented in this chapter, I contacted over 100 countries in less than a year's time while running five watts or less of power. As an additional check, I interrupted writing this chapter and used the outlined methods for QRP DXing on 30 meters. The results?

> Another QRP flash! Within a 30-minute period, I contacted Alaska, France, and the Falkland Islands while running a mere two watts RF output to a fullwave Delta Loop wire antenna. There were no unethical tactics or unique DX locations involved; you can accomplish the same results. Interested? Read on!

Getting Big Results With Low Power

The keynote to successful and enjoyable QRP operations involves three interrelated factors: **Station equipment, antenna system,** and **operator expertise.** Crystal-controlled transmitters are fine for pocket rigs and net operations, but the frequency agility of a VFO is vital to successful QRP work. If you plan to use a pocket rig for

camping or other size/weight/restricted activities, at least include a crystal-warping circuit so you can shift frequencies as necessary.

Your best bet is a modern-style transceiver with dual VFOs and memories. You have two choices here: A state-of-the-art 100-watt transceiver readjusted so its front panel control can reduce power to five watts or less output, or a dedicated QRP transceiver. The latter choice is preferred, as no one can question whether you were actually running QRP when making contacts. In other words, it eliminates all possibilities of QRP "fudge" (an area that always raises brows when we see incredibly high scores reported by "surprise" winners in QRP categories of large contests). If you plan to outwit the big guns, you must have a way to skirmish their strong signals with miniscule difficulty. Smooth-operating memories that require little VFO interaction are great for lining up several in-progress QSOs that you can switch between while continuing to tune for other stations. You also need a high degree of selectivity (like narrowband CW filters) for minimizing QRM. IF-level notch filters are also greatly appreciated. This is because you often realize best results when calling weaker (rather than stronger) stations. The *loud guys* usually have several stations answering their CQs, whereas weaker stations will listen closer for your QRP call. Full break-in operation is an additional asset that should not be overlooked. The ability to listen "in between" transmitted dots and dashes so you can hear your competition and perfectly time your calls has a 10 dB advantage in on-the-air operations.

Sharp operating tactics may compensate for some of the previously mentioned factors, but it requires significant skill. You can jot down frequencies and calls on

Figure 2-1—Well known DXer and QRP aficionado Ed deBuvitz, W5TTE, with his home setup. This "good guy of Amateur Radio" really knows how to pull weak signals out of the noise, and assists many newcomers getting into QRP. Photo courtesy of W5TTE.

scratch paper as a substitute for memories, and you can also learn to ignore extremely loud CW interference of one tone while listening to a weaker signal of another pitch, but take it from the voice of prophecy: It requires dedication and good nerves! Just ask our good friend Ed DeBuvits, W5TTE, shown with his setup in *Figure 2-1*. We vividly remember the "good ole days" when Ed carried triple sandwiches and a large pitcher of tea into the shack and spent many evenings in a single pileup to successfully work another "rare one" and increase his DXCC count. The results? Since 1986, Ed has worked 188 countries while running five watts and 110 countries while using less than one watt. Bear in mind, also, W5TTE does not use a beam. His main antenna is a horizontal Delta Loop. Ed, incidentally, can often be heard as the alternate net control of the QRP net that meets at 2300 GMT on 14.060 MHz Sundays. Ed and I agree full break-in capabilities give you a noticeable advantage for calling stations, although you may prefer semi break-in for actual QSOs.

Since QRP signals are usually weak, a good antenna system is your greatest asset. A popular three element beam is your best choice for 20 meters and higher frequency bands, and a dipole specifically cut for 80, 40, or 30 meters is a good choice for lower bands. Verticals are also a popular choice, but remember they must have a good ground/radial system and be mounted at least one quarterwave length from obstructions to effectively radiate a signal. Multiband antennas like doublets with tuned open-line feeders or G5RVs are not encouraged for QRP work: They are fine with 100-watt rigs (where a 50 percent loss of radiated power is acceptable), but they can shift a regular QRP setup into the milliwatt category. When you can look up at your antenna and feel a sense of pride (and think to yourself "Wow, what a big antenna for such a little rig"), you are on the right track to achieving big results with low power.

Again I emphasize sharp operating tactics make the big difference in QRP work. Indeed, the combination of positive thinking and operating expertise equals success. If you have the confidence to work any station you call, you will! Dale Carnegie's positive thinking works! Remember, however, there is a substantial difference between "knob twiddling" and operating like a pro. Whenever possible, try to be operational on a band slightly before it opens to your desired area. Search the band diligently, paying close attention to weaker signals (the strong stations usually get all the calls). Use your rig's memories to store ongoing QSO's/stations you wish to call later. Within a few minutes, you should be familiar with the band activity and be able to spot new DX stations as they come on the air. Choose your diversions from band tuning to contacting stations carefully. Following a few days practice, you should be contacting stations and DX right as they get on the air; generating pileups which others will join after your QSOs. Do not slacken your pace at this point: Increase it!

If you had been taking advantage of band openings and marginal signals on 20 meters, you have already reaped its best times during your first 30 minutes of operation. Switch to 15 meters and begin using similar procedures. After 30 minutes on this band, move up to 17, 12, or 10 meters. As evening hours approach, follow this band operating procedure in reverse while again listening for DX stations that appear

briefly before propagation fades. During slack periods, compare notes with other QRPers and DXers. You can both benefit, and your DXing success will increase tenfold. Let people know you are a QRP enthusiast, and they will help you along the way. We also suggest listening to and studying on-the-air habits of well-known QRPers and DXers presenting a professional and intelligent attitude. Be efficient, concise, and accurate in your operations, and you will soon acquire an honorable title among low-power aficionados and DXers everywhere.

Let's now concentrate on some additional ways to improve your QRP operating and DXing success. Achieving DXCC with QRP is much easier if you have already worked 100 countries "the easy way" with 100 watts. The skill and expertise acquired is a definite advantage for QRP operating. Additionally, you will learn even more skills while DXing QRP style and that will escalate your DXing abilities even more. Study signal propagation effects and use that knowledge to your advantage. The prime times for QRP DXing are when sunspot counts are high. Daily propagation forecasts and sunspot counts are transmitted by WWV on 10 and 15 MHz at 18 minutes after each hour. Use south hemisphere propagation during ionospheric storms affecting the northern hemisphere, and use the highest frequency band open during a specific time. Pay close attention when ionospheric storms end: The bands really jump at this time, and you can have a ball operating QRP. Many times, these measures will place the QRPer as one of very few United States stations on a band at a particular time. Low power shortwave broadcast stations and beacons within ham bands can also be used advantageously for determining when a particular band is open and to what area.

Figure 2-2—An ideal way to pursue QRP DXCC involves working "the easy ones" and exchanging QSLs via bureaus. You will probably work some rare ones "in the process and exchange QSLs directly, and that makes the game even more exciting!

Make friends with as many DX stations as possible. If, for example, you can schedule successful QSOs with 50 "easy-to-work" countries, you will be half way to DXCC. See *Figure 2-2*.

Get on the air at your least opportune and most overlooked occasions and never fall into a set routine of operating only during usual time slots. I have worked many new DX stations merely by flipping on the rig when I should have been dressing, doing home chores, leaving for work, etc. It is the old *they are never on the air when you are looking for them* syndrome. Solution? Look for good QRP success when you don't have time to get on the air. Unfortunately this scheme works! Remember, also, you cannot work DX if your rig is not switched on. One final tip: Only for the stout-hearted (!). Trade your house and car for a super DX location atop the country's largest mountain, purchase at least nine QRP rigs (one for each band), trade your wife for a maid (yes, I know, she already thinks she's a maid), quit your job, (declare bankruptcy after purchasing all DX needs!), and go for the gusto 24 hours a day. Enjoy, enjoy!

Special Tips on QRP DXing and Contesting

Although every technique for DXing is defined and refined in this modern age, we often hear rumors of special "tricks" used by the "big guns" to achieve honor roll standings. Are such operating procedures true DXing secrets? That depends on your present knowledge and expertise: If a previously overlooked idea improves your DXing success, it is obviously worth consideration. Bearing those thoughts in mind, the following information was compiled to help you enjoy QRP DXing and contest operating. In most cases, our presented information is simply popular accepted techniques endorsed by the general DX population (except for one or two personal opinions that crept in due to pure enthusiasm). May you find our suggestions useful for further escalating your QRP enjoyment!

Many of today's DXers use packetcluster assistance for finding DX on the air, and it may prove useful if your present country count is below 100. Remember, however, other Amateurs in your area are reading the same information and will be your competition in pileups. In many cases, this creates a flurry of semi-proficient operators overwhelming the DX station. A DX report on a packetcluster net is, in my opinion, "after the fact" news useful to only high power operators with plenty of time to spend in pileups. QRPers reap greater rewards by finding DX before they are listed on a DX packetcluster net.

Let's assume you find a DX station working callers at a relatively good pace and consider the best way to contact him or her. Stalk your prey: Try to assess their skills and reason their tactics. If the operator is efficient and well known, they may instinctively react to a well-planned call. If the operator is sending CW at a fast rate, call them at a faster rate (only one time with only your call letters and "QRP" followed by "KK") and be ready to copy the response immediately while others are still blasting the frequency with their call. This technique works, but you must be alert and ready to copy the DX station's reply. Do not call again if the pileup be-

comes a "round robin" with everyone trying to be a "tailender." Instead, shift your transmit frequency approximately 100 Hz and wait until the next time the DX station listens for calls or until you sense he has switched from transmit to receive. Listen for times when United States Amateurs QRM each other and cover the DX station sending QRZ. During this time, United States stations return to receive at exactly the same instant that the DX station returns to receive. Turn up your receiver's volume, use earphones, and you will spot this magic moment. This is the *ideal time* to transmit your call (only once). Remember, also, some top DXers can follow two or three minutes behind QSOs in their head, and exchange reports with stations after previously logging their call. If it seems the DX station is returning to a different group than those you are hearing, start noting calls to determine if this *follow behind* procedure is being used before you tune off frequency and miss your already-established contact. Try to place yourself behind the other operator's rig and reason their tactics.

Split frequency DX operations are often the easiest to work, regardless of the pileup. In this case, use your transceiver's second VFO for transmitting on the DX-specified receiving frequency while receiving the DX station on the rig's other VFO. Toggle between the VFOs so you can hear *both sides* of the pileup. With diligent tuning and studying, you will be able to spot each station making a DX contact. You can then activate your transceiver's *split button* for transmitting exactly where the previous station transmitted while listening on the DX station's transmit frequency. Watch your dual VFOs here: It is easy to make a mistake and transmit on the DX frequency while listening on the previous station's calling frequency.

An alternate concept also bears mention at this point. If the DX station indicates he is listening up 10 but making QSOs up 5, call him up 4. If the DX station says he is QSYing to 14,025 kHz, do not waste time to be the last contact before he shifts frequency. Move to 14,025 kHz and call the station twice with a double "K" at the end to indicate you are listening for him. **Being the first station to create a pileup is always better than joining a pileup.** If the DX station signs off the air for 15 minutes, do not waste time trying to change his mind. Set your timer and start looking for other contacts until 14 minutes later. Then return to the memorized frequency and listen for that first QRZ.

If the station you are trying to contact is not proficient in DXing tactics, you can expect to spend a significantly longer period of time pursuing a QRP contact. You should consider how important this particular contact actually is before settling into a hypnotic pileup trance or trying various strategies to get your call in the poor chap's log. Pay close attention to DXers making contact with the inexperienced station and determine why they managed a QSO. Was the DX station tuning up-frequency through a pileup? If so, move to the pileup's edge and call him. Were there lulls, or "holes" in the pileup where any station *filling in the blank* snagged a QSO? If so, carefully monitor the pileup for the appearance for such a "hole" and then place your perfectly timed and exactly transmitted call in there **one time.** There is one additional consideration that should be mentioned with this technique (which, incidentally, will prove very useful in a wide variety of DX pileups). You will prob-

ably get *only one chance* at the DX station before others realize your strategy and "close the hole." Check your plan thoroughly before blowing your chance. If necessary, practice off-the-air insertion of your call while listening to the pileup to determine how it will fit.

If you are entering a QRP contest and pursuing a high score, you will want to be operational from the opening minute. Aim for both contact and multipliers during the first few hours. This does not mean you should shy away from pileups which seem easy to crack, however, since band conditions may be favoring you at this particular time. If you can get through a pileup within five or six accurately placed calls, fine! Try your luck with another pileup and *go with the flow* while propagation is in your favor. Remember to not become boggled down to the point of staying in pileups for a long period. Stations will be much easier to work near the contest end. If you are entering a large contest in the QRP category, avoid heavily congested band edges until the second day of the contest. DX stations habitually work the strongest stations first, then listen for the weaker guys as *the going gets tough.* Finally, the bedraggled QRP contester may find consolation in the knowledge that every QRP contact is a reward in itself and *sticking with it* produces winning results. Never give up! If you decide to move away from the rig for a while, do not switch it off and turn on the "telly." Let the rig *play* at low volume for a while. You may be pleasantly surprised to later hear the prime opportunity for working a particular DX station.

Using Propagation Effects To Your Advantage

Few top-notch QRPers achieve outstanding results by simple games of chance and sheer luck operating. Instead, they plan on-the-air operations according to schedules and propagation forecasts. These forecasts are listed in monthly Amateur Radio magazines like *CQ*, *QST*, and *73*. Additionally, up-to-the-minute propagation forecasts are announced by WWV, the national bureau of standards, on 10 and 15 MHz at 18 minutes after each hour. Another useful operating aid is an accurate list of shortwave broadcast stations that transmit near Amateur bands. Such listings are often included in *Popular Communications* magazine (see *Figure 2-3*), and are worthy of consideration. If a broadcast station is heard at its usual signal strength (which you determine during previous SWLing times) rest assured your signal on an adjacent Amateur band will also be heard in the distant area.

Experienced QRPers and DXers are also familiar with propagation on various HF bands. DX openings on 40 meters, for example, usually affect a wide geographical area thus QRPers are competing with many others in trying to establish a successful contact. The only advantage you have in this situation is being close to the DX area. As an example, Amateurs striving to work Europe on 40 meters usually compete with all United States districts, yet New England Amateurs have a geographical advantage. Likewise, southern United States Amateurs would find South American QSOs on 40 meters relatively easy. 20 meters produces more geographically confined and distinct DX openings than 40 meters, and signal strengths are often higher during these times. The usual openings on 20 meters move across the United States in a *soft blanket effect*: The best conditions being exhibited at the leading edge of this hypothetical blanket. European openings, for example, move from east to west

across the United States As propagation shifts, midwest Amateurs can communicate better than eastern or northern Amateurs. As the hypothetical blanket's *leading edge* moves toward the west coast, W6 and W7s realize their optimum communications times. Eastern Amateurs will notice this specific time period by European signals dropping from 20 dB over S9 to below S9 levels. 15-meter DX openings are slightly more confined and pronounced than those on 20 meters, and the *blanket effect leading edge* is also shorter lasting. 10 meters is, likewise, quite similar to propagation on 15 meters. This means the *blanket's edge* on both 15 and 10 meters produces extremely good signal propagation and permits successful low-power operations right when the band opens and just before it closes. The previous facts are most pronounced during sunspot peak years. Adjustments must naturally be considered during years of declining sunspot activity.

Looking closer at signal propagation effects, we find that various layers of the ionosphere determine which Amateur bands are "open" at various times of the day. Let's now discuss this unique "radio mirror in the sky." Two basic types of waves eminate from an Amateur's antenna: A ground wave and a sky wave. In the case of HF communications, the ground wave is primarily used for line-of-sight communications, while the skywave is reflected to distant lands by the earth's ionosphere.

The ionosphere is located approximately 50 miles to 250 miles above the earth: It is composed of rarified air and gases which become ionized by photon and ultraviolet energy emitted by the sun. This energy varies in quantity and form, thus ionizing various levels of the ionosphere. As transmitted skywave signals hit the ionosphere,

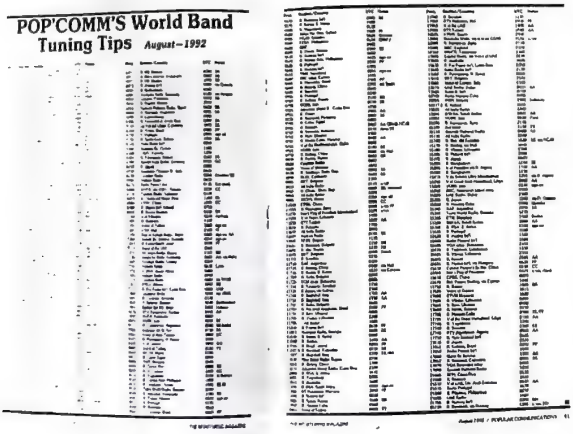

POP'COMM'S World Band
Tuning Tips August—1992

Figure 2-3—Tuning in foreign broadcast stations listed monthly in Popular Communications magazine gives you a quick and easy overview of DXing conditions and band propagation.

they are "reflected" (actually they are *refracted*, but reflected is easier to visualize) toward distant points on the earth. The ionosphere may thus be visualized as a variable density electrical mirror for radio waves. Without this ionosphere, our HF signals would not be able to "bounce" around the world. The primary layers of the ionosphere affecting long-range communications are shown in *Figure 2-4*. The lowest area of the ionosphere is the D-layer, which is located approximately 40 to 60 miles above the earth. This layer hinders rather than helps DX communications on the the HF bands because it absorbs or attenuates signals rather than reflecting them. Any signal that is reflected back to earth by the low altitude D-layer is restricted to short or medium distances.

The E-layer is located approximately 60 to 100 miles above the earth, and it also affects long distance communications on the HF bands. If the E-layer is ionized (which usually happens around one's local noon hour), it becomes a good reflector for radio signals. The signals reflected by this medium height layer, however, cannot attain the long range produced by higher located F-layers. The logic here is quite simple: The higher the ionospheric reflection, the greater the first skip distance, and this first skip yields the greatest DX range. Sunspot counts over 150 directly influence the E-layer, and usually produce skip conditions on 10 and 6 meters. Another phenomena that occurs mainly during spring and early summer is *sporadic E-openings*. This effect, which is caused by variations in normal amounts of ultraviolet energy hitting the E-layer, sporadically ionized patches that reflect 10 and 6 meter signals.

The F-layer is directly responsible for most long range HF communications. Since this layer is closest to the sun, it receives a maximum amount of photon and ultra-

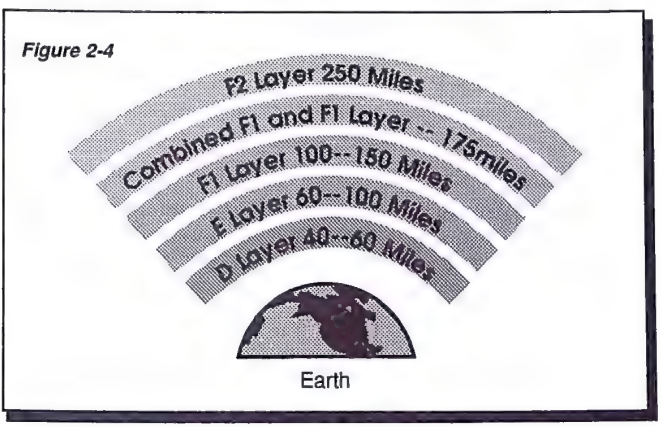


Figure 2-4—Primary layers of the ionosphere and their approximate position above the earth. Altitudes vary with seasonal changes and sunspot cycles. Discussion in text.

violet energy. During daylight hours, the F-layer splits into F1 and F2 layers. During evening hours, these layers combine into a single (and slightly lower altitude) F-layer. The F-layer is usually located at 250 miles maximum height during summer and 175 miles during winter.

Sunspots are explosions of tremendous magnitude on the sun's surface. During these explosions, large amounts of photon and ultraviolet energy are released. This energy influences the earth's tides, general weather conditions, and the ionosphere. The larger the sunspot count (higher the energy from the sun), the greater the ionosphere's signal reflectivity. Obviously, the higher F1 and F2-layers are most affected by high sunspot activity. All layers of the ionosphere will be affected by sunspot activity, however, since the closest-to-the-sun F-layers do not block or absorb all of this energy. Sunspot activities occur in an approximate 11 year cycle, thus HF communications also follow a similar 11 year pattern of great and poor DXing conditions. Occasionally during years of declining sunspot activity, solar flares (massive explosions on the sun's surface that produce vast amounts of ultraviolet energy) cause extreme ionization of the ionosphere's D-layer. This results in a mass absorption of radio signals: An ionospheric storm. Ionospheric storms are usually accompanied by magnetic storms and poor HF conditions. Recently, Amateurs have found UHF propagation and tropospheric ducting enhanced during magnetic storms. Following a magnetic storm, sunspot counts and HF DXing conditions usually boom. Since half the fun of QRP is building small circuits and the other half of the fun is operating low power rigs on the air, use the time during magnetic storms for homebrewing and enjoy operating like crazy during the peak times afterwards. Good luck, and may you always enjoy top QRP DXing success!

DXing The HF Bands

As briefly mentioned on previous pages, each HF band is unique in characteristics, range and time of daily openings. This is quite attractive for Amateur Radio use, as we can select a particular band for contacting desired areas. Experienced Amateurs are probably familiar with characteristics of most HF bands but newcomers will surely appreciate helpful guidance in this area. The following brief overviews are thus presented to ensure your life as a QRPer and radio Amateur are a rollicking success.

Ten meters is Amateur Radio's highest HF band, and it is also one of the most unique. Signal propagation on 10 meters is directly influenced by sunspot activity: During times of low sunspot counts, the band is closed for DX and during high sunspot counts, 10 meters is wide open for worldwide communications with very low power. Ten meters is basically a daytime band that opens approximately three to four hours after sunrise and closes approximately one or two hours after sunset. The most opportune times for 10-meter DXing is during the spring and fall, particularly around Equinox (when equal hours of daylight/darkness occur). There is a mid-summer and mid-winter slump on this band that often results in only north-south propagation. A relaxed DXing atmosphere coupled with relatively uncrowded frequencies (except during contests!) make 10-meter operation quite enjoyable. Many Amateurs

are able to conduct extended and truly meaningful DX conversations during weekdays on this congenial band.

The Novice/Tech range of 28.300 to 28.500 MHz is terrific for talking with Amateurs in the United States and overseas almost daily. Since their maximum legal limit of power is 250 watts, it is a shining example of what can be accomplished with medium power. Thus, QRP operations on 10 meters are terrific! Please do not overlook the Novice/Tech CW range of 28.100-28.300 MHz. Packet and AMTOR communications frequent the extreme low edge of this range, but CW operations between 28.120-28.150 MHz are great!

The 12-meter WARC band is very similar to 10 meters in times of opening and range. Many Amateurs overlook this band because 12-meter contacts are presently not accepted for WAS and DXCC awards credit. The combination of low activity on 12 meters, use of barefoot transceivers and basic style antennas make this band great for QRP operation. Running 50 watts on 12 meters is equivalent to running 300 watts on 20 meters. If you want to have some real fun with QRP, check out 12 meters. It is a super band.

The 15-meter band exhibits characteristics similar to both 10 and 20 meters, it supports outstanding DX activities, and 15 meters usually opens before and closes after 10 meters. The 15-meter band is typically open 11 out of 12 months each year, with signals peaking during late morning and early evening hours. The communications atmosphere on 15 meters is friendly but somewhat competitive, as many "big gun" DXers realize the benefits of this band. The sharpness of DX paths on 15 meters aid in reducing interference levels. Working against this propagation when trying to contact a station, however, may cause one to spend several hours without achieving success. This is one of the important considerations for both 15 and 10 meter operations: Knowing when to begin, and when to stop. It is difficult to beat the odds when propagation is against you!

The 17-meter WARC band exhibits characteristics similar to both 15 and 20 meters, and its CW subband of 18.068-18.110 MHz is an exceptionally good QRP operating range. Activity on this band is increasing almost daily, but most United States operators use SSB rather than CW. This situates the CW QRPer in a very good position: A few watts will work the world. Watch for 17 meters to open slightly after 20 meters, but before 15 meters opens for daily activity.

The 20-meter band is the focal point of all big time DXing activities. This band is open to more areas of the world for longer periods each day than any other band. If an Amateur is confined to a single band of operation due to economic or antenna limitations, 20 meters is the optimum choice. Likewise, 20 meters supports the largest number of DXers running high power signals. Operating this band with QRP requires patience, perseverance, and skill (similar to going bear hunting with only a hickory stick!), yet the rewards are tremendous. The QRP DXer will realize maximum benefit when operating 20-meter CW. If you hold a General class license, op-

erate in the QRP-favoring area of 14.060-14.070 MHz. If you have an Extra class license, operate in the 14.000-14.025 MHz range (and add 6 dB to your QRP clout). The most opportune times to work 20 meters are around dawn, dusk, and right before retiring for bed. Unlike other high frequency bands, 20 meters seldom suffers seasonal slumps. It is open to one area or another of the world most of the year.

The 30 meter WARC band is unquestionably a QRPer's haven. This is the only HF band with a maximum United States power limit of 250 watts, so everyone uses a "barefoot" transceiver. The usual antennas on this band are dipoles rather than beams, again encouraging the use of low power. Indeed, a 5-watt rig connected to a properly tuned dipole is only four "S" units (at worst) below a "big signal" on 30 meters. Voice operations are not permitted on 30 meters, so it is often overlooked by numerous United States Amateurs. This gives the QRPer an even greater advantage! Propagation on 30 meters is a combination of 40 and 20 meters, which means it is open for stateside contacts almost 24 hours a day. Optimum DXing times typically situate Australia, Japan, and South Pacific areas' signals coming into the United States around one's local sunrise, while Europeans' signals come in around sunset (and continue until after midnight). Good DXing results on 30 meters usually occur when darkness is ata the midpoint of a particular path. The strength of DX signals can be quite surprising: Indeed you may think it is a dream until the QSL card arrives as proof! If you wish to experience some outstanding and successful QRP operations and have a ball on CW, 30 meters is the number one band of choice!

The 40 and 80 meter bands are almost inverse copies of the 15 and 10 meter bands. 10 meters is a daytime band and 80 meters is a nighttime band. 15 meters closes during early evening hours and 40 or 80 meters closes soon after sunrise. 10 and 15 meters are high sunspot activity bands while 80 and 40 meters are low sunspot activity bands. Antennas are very important to 40 and 80 meter QRP operations, but their large size makes erecting big antennas difficult. Dipoles, with their unity gain, are your usual choice. DXing with this basic-style antenna is challenging. The majority of QRP DXing on 40 and 80 meters is conducted within the first 35 kHz of these bands. The range of 7.040-7.050 MHz is especially good for QRP operating, as nets are on these frequencies almost daily and QRPers are always listening for their friends and aficionados. Although 80 meters is not a DX band per se, a significant amount of *local area* QRP activity will be noted between 3.550 and 3.570 almost every evening.

DXpeditioning With QRP

At least once in every QRPer's life, the call of the wild (no pun intended!) strikes a resounding blow and the urge to actually be the DX is inescapable. This Amateur initially visualizes operating from some exotic island or remote area, passing out contacts to the world at large, and earning a number of highly sought DX awards in the process. The dream continues and the QRP DXpeditioner rapidly acquires "itchy feet." Maps and country lists are studied, DX requirements are reviewed time and time again, and DX advisory committees are consulted regarding licensing. Slowly, the DXpedition begins to formulate and become reality. Finally, an expedition (which may be quite different from original dreams) is formulated and the Amateur

realizes the true excitement of being on the other end of a pileup. DXpeditioning is a fever, however, and once simply is not enough. After returning home, the DXpeditioner may again start getting that far-off look in the eye and begin thinking of bigger and better DXpeditions.

There are two basic types of DXpeditions: The all out, serious gusto endeavor, and the casual yet quite enjoyable DXpedition/vacation combination. The Colvin's Yasme DXpeditions and the travels of Martii Laine (OH2BH) are typical examples of serious DXpeditions. A combination vacation and mini DXpedition usually involves carrying ham equipment to some Carribean area or even one of the many IOTA (Islands On The Air) Islands off the United States coast.

Since the DXpeditioner is aware that expeditions are expensive and difficult endeavors which may not be repeated, he or she wants to ensure everything will go as smoothly as possible. He obviously does not want to travel a significant distance and plan operations to coincide with a major DX contest only to find his license is not valid (see *Figure 2-5*), his rig has developed problems or antennas cannot be quickly erected. Likewise, the DXpeditioner does not want to lose gear during transit or have it confiscated by Customs officials (the beauty of small QRP gear: It can be hand-carried when traveling). Fine, you say, but how can one predict such situations. Extenuating circumstances do arise, but their odds of occurrence can be reduced by careful planning and commonsense reasoning. Would you purchase a new auto and immediately put it on a long trip before checking the vehicle out around town? By the same token, a *tried and proven* rig is more desirable than an unfamiliar trans-

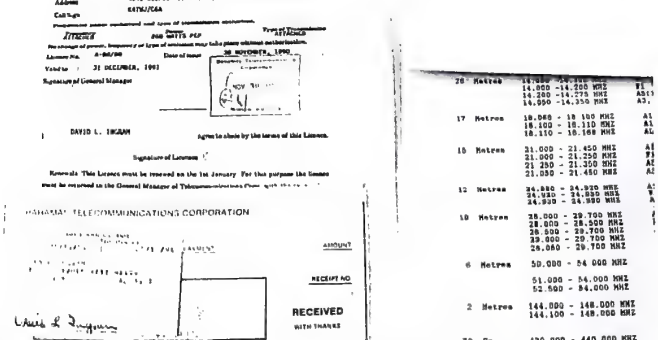


Figure 2-5—The first step in any DXpedition involves obtaining a license to operate from that country, and it should be obtained well in advance. Renewing the license each year thereafter assures you are again ready to "be DX" on a moment's notice.

ceiver–unless a backup station is also carried along. Would you begin a cross-country trip without a spare tire or basic items like repair tools and extra coolant? Likewise, spare parts for rigs, extra fuses, a volt ohmmeter, and extra wire should be a natural part of your DXpeditioning paraphernalia. The most reliable means of insuring you are not separated from your rig is simply hand-carrying it in a small flight bag. Remember: Without operating ham gear, there is no DXpedition!

A number of basic considerations apply to every DXpedition: Where to go, the general status of that area and its licensing requirements, power sources, travel requirements, and extra money for *unforeseen surprises*. While planning this endeavor, the *first time* DXpeditioner can acquire a feel for pileup operating by setting up a mobile station in a rare county near his city. The International County Hunters Net operates on 14.336 MHz, and their activities are discussed each month in *CQ* magazine. If a county DXpeditioner make the intentions known to this group, he or she will find an eager and enthusiastic number of county hunters ready to pounce on his rare county expedition. When activity wanes, moving to another county will start the pileup again. Within a few days after county expeditioning, QSL cards will begin filling the Amateur's mailbox, providing an idea of that aspect in expeditioning.

The casual DXpedition may necessarily be limited to minimum on-the-air activity and enjoying the vacation most of the time. This should not preclude laying foolproof plans just as one would for a serious DXpedition. A license for radio operation from the desired area should be obtained beforehand. The American Radio Relay League has information on licensing in many foreign countries available upon request. The majority of casual DXpeditions usually involve nearby countries like the Bahamas, Cayman Islands, Jamaica, Aruba, etc. Few problems with licensing, customs, and power sources are encountered in these areas. As an additional and *backup measure* the expeditioner is urged to contact Amateurs native to the country he or she will be visiting. The asset of knowing these people will prove invaluable should unforeseen problems arise. There are many times when travel bureaus are also advantageous, like when making airplane reservations, planning lodging, etc. Remember to secure accurate figures concerning baggage weight limitations and restrictions concerning carry-on baggage. Whenever possible, emphasize the publicity aspect of your jaunt. Notify DX editors of magazines and DX bulletins of your plans. Be as exact and precise as possible, and a group of DX-hungry stations will await your activity.As additional encouragement to pursue your own mini DXpedition, we urge you to check out the European-sponsored *Islands On The Air* program. Information on this outstanding DX award is available by sending two dollars to the *DX Bulletin*, P. O. Box 50, Fulton, CA 95439. The basic IOTA award is quite beautiful and available for contacting 100 islands. In addition to details for pursuing this award, your return package from the *DX Bulletin* will include a large list of IOTA-authorized islands. Several of these islands are only a few miles off United States coast lines: Some can be reached by bridge, others by boat. Getting on the air with QRP from Catalina Island off the California coast, Martha's Vineyard out from New England, Dry Tortigas off the Florida coast, etc. is an absolute blast of *weekend DXpeditioning fun.*

Chapter 3

Commercial Equipment For QRP

A really impressive selection of commercially manufactured QRP equipment is readily available to today's modern Amateur. Getting started in low power activities, therefore, is truly quick and easy. This chapter will overview pre-assembled units from major name manufacturers. It will also discuss several units presently available in kit form, plus some designs you can home-assemble as desired. Like any new-to-you mode of communication, selecting the equipment for your needs and interests is best determined after a brief on-the-air exposure. True indeed, for how can you know or realize a preference in new pursuits until you have encountered them! Once again, I suggest the obvious method of initially reducing the RF output power of your existing HF transceiver and operating QRP for a few days while studying your natural habits. Do you find dual VFOs and multiple memories helpful, or do you prefer the simplicity of a single-VFO transceiver? Is weight and size a primary consideration to your QRP activities? Do you have the ability to mentally filter out undesired stations or need the advantage of narrow filters and passband tuning? Do you enjoy mixing SWLing and QRP operating? Answering questions like these will give you a clear view of the type QRP equipment you will most enjoy.

Most of today's popular 100-watt transceivers are easily readjusted or modified for QRP operation, and minimum output can usually be set down to the milliwatt range while maintaining a full 100-watts output at the control's maximum setting. The true QRPer, however, will also want to add an accurate wattmeter to this unit, especially if QRPp-type pursuits are contemplated. Deluxe-style 100-watt transceivers with the dual VFOs, multiple memories, narrow filters and passband tuning/IF shift, plus selection of full or semi break-in is truly going QRP first class. It also demands high integrity on the part of the owner, not to mention sincere honesty with regard to claimed/used power levels! In other words, it is easy to indicate that you're running one watt when in fact, you are actually running 50 watts. Even if such QRP "fudge" tactics are never discovered, they defeat the purpose and enjoyment of using low power and unnecessarily eliminate personal pride in such achievement. Understand,

I am definitely not trying to steer you away from power-reduced 100-watt transceivers for QRP (they are absolutely tops and their features are terrific!). But please just remember which setting of the RF output control is maximum and which is minimum!

Personally, I prefer using a dedicated-QRP transceiver for low power operating. This eliminates any possibility or question of running high power and produces a *total QRP* attitude. But that is only my personal opinion, and actually only holds merit if another Amateur sees me in operation and knows that I'm using my only rig. But wait, are not most QRP transceivers limited in performance? Yes, the still popular Heath HW-7, HW-8, and HW-9, and the early model Ten-Tec Argonaut are no longer produced. They require a reasonable amount of operator expertise to supplement design shortcomings, but they are still fun rigs! Alternately, Ten-Tec's recently introduced Argonaut II is a very impressive performer. I must agree, however, that ultra deluxe *big rigs* have unlimited QRM-combating features. And combining two pursuits (daily activities and QRP) in one unit is logical thinking. Try QRP for a month or two, then make your own decision. Maybe owning both is the perfect answer! That's right: Then you will have a deluxe QRP rig for home use and a neat little portable QRP rig for camping and vacation. Enjoy!

Modifying 100-Watt Transceivers For QRP

As previously mentioned, most modern 100 watt and all solid-state transceivers are easily modified for QRP and milliwatting operation. Exact procedures vary according to manufacturer and model, but the following overview will give you a reasonable working knowledge of what is involved and how easy *going QRP* can be. Additionally, we urge you to contact your particular transceiver's manufacturer for specific details and confirmation on our suggested modifications. Remember, no one knows a transceiver better than the manufacturer. Technical assistance is as close as your telephone: Use it!

Most Icom transceivers like the IC-730, IC-735, IC-751A, etc. can be reduced to approximately 10-watts output by way of their front panel RF power control. A small internal potentiometer can be readjusted so that minimum output is approximately 4 watts. The exact procedure for readjustment was described in a recent *Tech Talk from Icom* and is reproduced here for your convenience. A one-time internal adjustment is all that is required to give you front panel RF power control selection of 100-watts output in the fully clockwise position, and approximately 4 watts in the fully counterclockwise position. This gives you instant selection of QRP or QRO as desired.

First, remove any rings or watches when working inside any equipment. Although Icom transceivers (and all solid state transceivers) do not employ vacuum tubes and dangerous high voltages, metal objects can unknowingly create shorts in any circuit. Be sure you have plenty of light to see what you are doing and, if necessary, use a pocket magnifier for reading component numbers on circuit boards. Also avoid moving wires or cables that can become pinched after replacing the rig's cover.

The IC-735 is easily reset for five watts or less on all modes as follows. Place the IC-735 upside down on a soft towel with its front panel and knobs facing you. Remove the 8 screws from the bottom cover and lift it off to expose the main circuit board. Look in the upper right corner, and you will see four small potentiometers in an L-shaped pattern. Locate R-267 near the bottom of that "L". It sets the low end of the front panel's RF power control. Connect an accurate wattmeter from your antenna or dummy load into the IC-735's rear socket, switch the transceiver on, and adjust the RF power control for minimum. Select CW operation and key the rig only long enough to read the wattmeter. Power output will typically be 10 watts. Place an insulated screwdriver on R-267 and again key the rig. While watching the wattmeter, turn R-267 clockwise until the RF output drops to five watts (or even lower, as desired). If more than 30 seconds are required for precise adjustment, switch the IC-735 back to receive for 30 seconds before repeating the procedure. Rotate the front RF power control to maximum, note full output, return to minimum and double-check your QRP output, then switch off and reassemble your QRP-ready IC-735.

A similar adjustment procedure applies to Icom's IC-751 transceiver. In this case, internal potentiometer R-46 is reset so the front panel RF power control gives five watts (or less) at minimum. R-46 is located under the IC-751's top cover and in the center of the main circuit board. It is to the left of the large shiny shield in the board's exact middle.

Resetting Icom's IC-725 or the new IC-728 shown in *Figure 3-1* for five watts minimum output is also a cinch. Set its front RF power control to minimum, then adjust R-208's setting until your wattmeter indicates five watts (or less). When the IC-725 is upside down and its knobs are facing you, R-208 is located in the main circuit board's top right quadrant (R208 is located in the main circuit board's exact middle on the IC-728).

Figure 3-1—Modern 100-watt HF transceivers like the Icom IC-728 are easily reset for five watts or less output, and they make a terrific QRP transceiver. Photo courtesy Icom America

Icom's IC-781 is QRP-ready via its front panel controls. Rotate the RF power to minimum, then decrease the drive control until five watts (or less) is indicated on the wattmeter. Icom's IC-751A and IC-761 are slightly more difficult to adjust for five watts or less output, so I recommend that you telephone Icom's Customer Support Hotline at (206)454-7619 for details.

The front panel power output or carrier control on most solid-state Kenwood transceivers permit adjustment into the milliwatt range as-is. You only need a very accurate wattmeter for setting and monitoring output power (several models "drift" in output when set below their maximum level). Let's now look at some specific models. Front panel adjustment of the carrier control to minimum on Kenwood's TS-120, TS-130, TS-140, TS-430, TS-440, TS-930, and TS-940 will move them into the QRP range on CW. Exact settings for power levels like two or three watts often should be monitored as the rig warms up. Low end output of these transceivers is usually in the 20-50 milliwatt range. Some owners of TS-940s report their rig will only go down to four watts on CW. If you notice this situation, its low end adjustment is accomplished by way of VR-19 on the control board. Kenwood's new TS-850 and TS-450 have two controls for power reduction—the carrier control and the power control. Combined use of these two controls will usually move output into the low milliwatt range.

Although information was not available on Yaesu transceivers, they appear to be equally suited for QRP operation and easily modified for very low output. We encourage you to check with a dealer for specific details. Alternately, our external modification shown in *Figure 3-2* can be used with nearly all available 100-watt transceivers for reducing their output.

The circuit shown in *Figure 3-2* is a simple voltage divider consisting of a 100k ohm pot, connected in series with a 1.5 volt battery. This arrangement is used to apply a

Figure 3-2

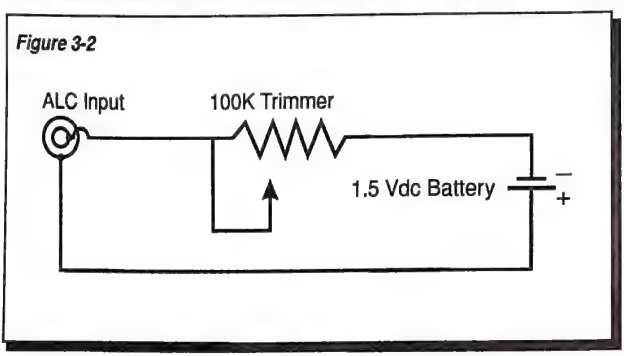


Figure 3-2—A universal and easy-to-implement external modification for QRPizing most 100-watt trasceivers. Typical rig output will be 5 watts at 1.24 volts and 100 mW at 1.33 vdc. See text for a further explanation.

negative ALC voltage to the transceiver's rear ALC input, thus simulating the connection of an external linear amplifier and reducing transceiver output power accordingly. Check your rig's instruction manual for exact connection/pinout wiring to the rear panel phono or DIN socket. Adjust the potentiometer until power output of your rig drops into the desired low-power range. Typically this will occur when approximately 1.2 volts is applied to the ALC connection. Current drain on the battery is approximately 1 mA, so life expectancy is very good. If you operate QRP only a few hours a day, there is no reason to substitute an external power supply here. The attractive aspect of using this ALC-adjusting approach to QRP-adapting modern transceivers is convenience. You simply need to plug it into the back of the radio whenever you desire low power operation. When the battery adapter is unplugged from the transceiver, power output returns to maximum.

Two final notes. Remember to check your transceiver's instruction manual before connecting our universal ALC mod, to ensure that you have the polarities correct. Remember this simple technique for use with future model transceivers. Nearly every model of Ten-Tec transceiver can be modified for QRP use with minimum difficulty. This company has been promoting QRP ever since they went into business!). For exact details, however, you are encouraged to contact Ten-Tec directly. I again emphasize that no one knows a particular model transceiver better than its manufacturer.

Ten-Tec and The Argonaut Legend

Although the classic Ten-Tec Model 505, 509, and 515 Argonauts are no longer manufactured, this always-popular QRP transceiver continues to appear in hamfest fleamarkets nationwide. We are thus proud to relate the following story of its history. Prior to the 1960's, QRP equipment centered around home-constructed low power transmitters used with separate shortwave receivers. During the mid '60s, a small and newly formed company in Sevierville, Tennessee, Ten-Tec, Inc. intro-

Figure 3-3—The classic Ten-Tec Power Mite triband QRP transceiver. This unit introduced numerous lower power enthusiasts to all-solid-state rigs and was the beginning of the famous Argonaut transceiver line. The unit was produced during the mid-1960s, and is a genuine collectible today. Photo courtesy of Ten-Tec, Inc.

Figure 3-4—The original and tan-cased Ten-Tec Argonaut QRP transceiver. Used models of this all-time favorite rig still surface in hamfest fleamarkets, and they are always snapped up by enthusiastic QRPers. Photo courtesy of Ten-Tec, Inc.

duced a modularized CW-only system called the *PM transceiver*. One of these now-rare and quite collectible rigs is shown in *Figure 3-3*. Our thanks to Ten-Tec for this photo. The PM I and PM II were available at very low cost as separate boards (VFO, receiver, transmitter, etc.) or pre-assembled (priced between 59.95 and 79.95). The little transceivers became so popular, that Ten-Tec soon replaced them with a more advanced SSB/CW transceiver known as the Argonaut.

The original Argonaut 505 is shown in *Figure 3-4*. It featured 5 watts input and 2.5 watts output. It operated SSB and CW on the 80, 40, 20, 15, and 10 meter bands. This tan-cased unit with its 4.5 x 13 x 7.5 inch cabinet (H,W,D), resembled a bread box. The unit soon became an absolute favorite among QRP enthusiasts everywhere.

Figure 3-5—The later model and black-cased Argonaut 515. This impressive looking and high-performance transceiver introduced Amateurs around the world to QRP. Demand for the Argonaut 515 continues high today. Photo courtesy Ten-Tec, Inc.

The Argonaut introduced Amateurs around the world to QRP. The rig tuned quite smoothly, featured an internal speaker, full CW break-in, etc. It was a gem. During the latter part of the 1970s, Ten-Tec replaced the tan-cased 505 and 509 Argonaut with a black-cased Argonaut 515 shown in *Figure 3-5*. In the same way Britain's classic MG introduced America to true sports cars, Ten-Tec's 515 Argonaut introduced many Amateurs to QRP. The Argonaut's wide front panel and large dial gave the impression of a full-size United States manufactured transceiver. Frequency calibration to 1 kHz was included on the main tuning knob's skirt, while the slide-rule dial showed approximate frequency within each 100 kHz range. The knobs were arranged in a functional and uncluttered manner, and there was a finger hole in the cabinet's bottom for adjusting sidetone, volume, and frequency. A front tilt bale angled the unit for comfortable use while directing sound from the bottom-mounted speaker toward the operator. The unit was fully solid state and could thus be switched on and operated immediately. Band changing was easy and only required a mere peaking of the receiver's RF tuning or resonance control. A large front-panel bezel with recessed meter gave the unit a quite attractive appearance. During operation, the forward power/SWR/S-meter and large dial were illuminated by a small lamp. Another lamp under the bezel illuminated the tuning knob's pointer and skirt. LEDs on each side of the bezel indicated receiver offset tuning and RF output. Since the unit featured full CW break-in, the LEDs flickered in synchronization with transmitted Morse code—a glamorous display indeed! The new Argonaut 515 included every feature that its predecessor did, in addition to a far superior receiver front end, improved IF filters, and a new VFO design. Your author had the pleasure of reviewing an Argonaut 515 during its heyday, and its enjoyable operation is still vivid in my mind today.

I remember operating the Argonaut 515 just like it was a regular 100-watt output transceiver, and results were very good indeed! Most of my contacts were via CW on 20, 15, and 10 meters. Contacts with Italy, France, USSR, Japan, Barbados, Bahamas, Puerto Rico, and Australia were achieved in the first week's operation. Indeed, the first hour's operation netted contacts with 10 countries—all while using only 2.5-watts output. The Argonaut's most attractive feature was its full CW break-in. This ability to hear on-frequency activity in between transmitted dots and dashes is always beyond comparison. Knowing exactly when to call a station or slightly shift frequency, and knowing exactly when the other station was listening were real DXing assets. The Argonaut's overall performance was smooth and enjoyable—really fun! I must also say my previous discussion applies to all model Argonauts: The 505, 509, and 515. Additionally, these *basic style* transceivers (compared to modern units with deluxe amenities) continue to be sheer QRP delights today. There is a special magic in owning and using an Argonaut: Try one. You will love it!

The Argonaut II

After a lengthy period of silence and several years after the Argonaut 515 was dropped from production, rumors of a completely new Argonaut began circulating in the QRP community. Then, during 1990, first sketches of the new Argonaut II appeared in very limited quantity. Approximately a year later, first advertisements of the new Argonaut II appeared in Amateur magazines. The Argonaut II, shown in

Figure 3-6—Continuing the legend is Ten-Tec's new Argonaut II: A modern-style, compact transceiver with features galore. Photo courtesy Ten-Tec, Inc.

Figure 3-6 is significantly different from its forerunners. It is a modern QRP transceiver in every sense of the word, and it is most definitely high tech!

The Argonaut II is enclosed in a black case measuring 3.75 X 9.75 X 12.5 inches (H,W,D) and weighs only 8 pounds. It has an LCD readout that shows frequency, time, S meter, output power, and SWR. The meter's scale is also used to display VOX and other control settings, plus the backlight can be switched on/off to minimize current requirements.

The Argonaut II covers 160 through 10 meters, and it receives from 100 kHz to 30 MHz. Power output is five watts on SSB, CW, AM, and FM. Output can be reduced down to 500 mW via the front panel's *PWR* control. Ten-Tec's famous ultra-quiet full break-in is included in the Argo II, and this single feature truly makes QRP operation a sheer delight. The Argonaut II's receiver features passband tuning. In addition, its bandwidth is continuously adjustable from 2.4 kHz to 500 Hz. An adjustable notch filter is included for cutting out heterodynes and QRM. The transmitter has an effective speech compressor that really boosts the average talk power. The rig features dual VFOs, plus 31 memories–10 of which can be programmed for split-frequency DXing. The rig's tuning rate is adjustable from a slow 10 Hz to 50 Hz to coincide with preference. Naturally, additional *big rig* features like VOX, CW sidetone, etc. are included in this no-compromise QRP masterpiece.

Your author recently had the honor of reviewing an Argonaut II on-the-air, and I loved it! The difference between two watts (older Argonauts, Heath HW-8, HW-9, etc.) and the Argonaut II's five watts makes a big difference in making solid contacts. That is especially true on 30 meters, where five watts can work the world! I contacted a large number of good DX stations with the Argo II (naturally), and stateside QSOs were a blast. It was just like running a 100-watt transceiver! The passband tuning and adjustable IF bandwidth proved terrific for CW work, and—frankly—the only hesitation I experienced was returning the Argo II to Ten-Tec after review (one can really get attached to this little gem). Speaking of size, in-

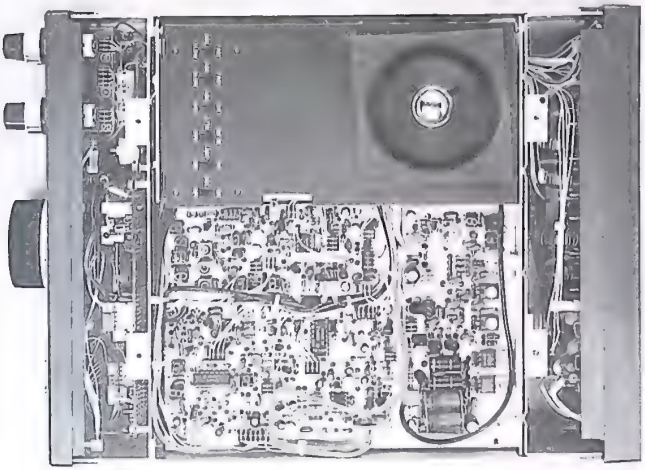


Figure 3-7—Inside view of the Argonaut II. This little rig is loaded with impressive circuitry, and it also seems quite easy to service. Photo courtesy of Ten-Tec, Inc.

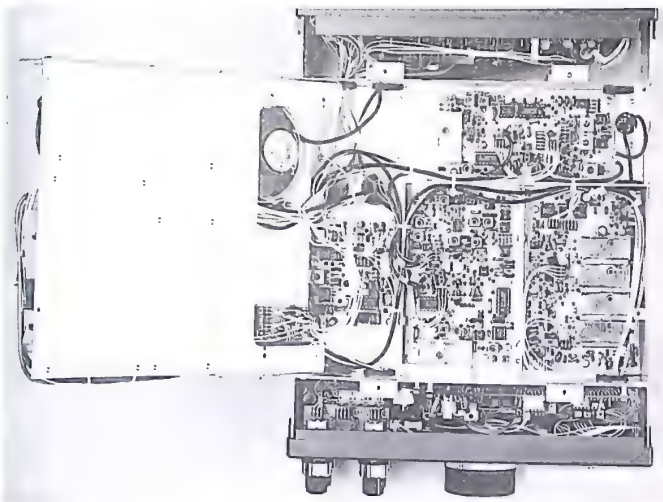


Figure 3-8—The upper circuit board in the Argonaut II swings open to reveal even more impressive circuitry. Photo courtesy Ten-Tec, Inc.

cidentally, the Argo II really fits in the smallest space. It is even smaller than Ten-Tec's famous Delta II because there is no external heatsink on this QRP delight. Like any enthusiastic Amateur, I was quite curious about the Argo II's "innards." When the top cover is removed, the rig looks like *Figure 3-7*. The transmitter's final amplifier is at the rear. The speaker is on the left, and a variety of top adjustments are accessible via a hatch. The main circuit board sits below the speaker and swings open to the left for accessing additional circuit boards below (see *Figure 3-8*). Another circuit board—equally as packed as the top board—is accessible by removing the transceiver's bottom cover. This rig flat out has the circuitry to do an incredible job!

I cannot praise the Argonaut II high enough, and can fully understand why serious QRPers are ordering them almost faster than Ten-Tec can deliver. It is yet another classic in the world of QRP! For more information on the Argonaut II and other Ten-Tec equipment, contact Ten-Tec directly: Highway 411 East, Sevierville, TN 37862. Telephone 615-453-7172.

MFJ-9020 QRP Transceiver

During the Spring of 1992, MFJ Enterprises of Box 494, Mississippi State, MS 39762, introduced their new five-watt 20-meter CW transceiver for QRP. This little tyke measures only 2.25 X 6 X 6.5 inches (H,W,D), and covers 14.000 to 14.075 MHz. It has a superheterodyne receiver with a built-in 500 Hz filter, RIT, audio-derived AGC, and adjustable semi break-in. There is also a CW sidetone, built-in speaker, and earphone jack. The MFJ-9020 is powered from an external 12 volt source. Options for this transceiver include a plug-in keyer (MFJ-412) and narrow audio CW filter (MFJ-726). The MFJ-9020 transceiver is shown in *Figure 3-9*, and an inside view of the transceiver is shown in *Figure 3-10*. The receiver section is on the right, and the transmitter is on the left. Look closely and you will see that the output transistor bolts to the cabinet's bottom for heat sinking. The two boards shown at the rear are the optional keyer and CW narrow filter installed in position. For stand-alone portable operation, the MFJ-9020 transceiver can be combined with

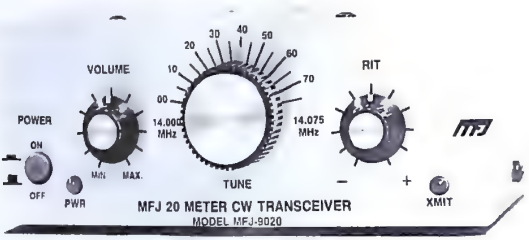


Figure 3-9—The MFJ-9020 20-meter QRP transceiver. Additional models for other bands are also available. Photo courtesy MFJ Enterprises, Inc.

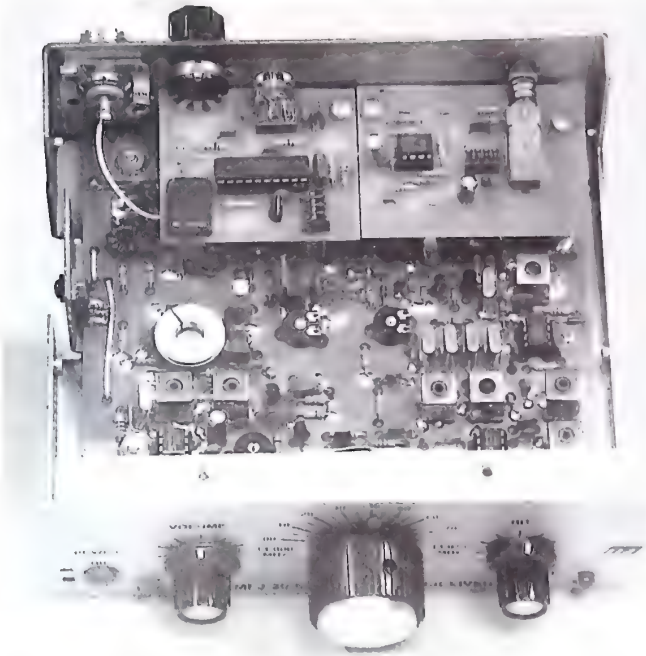


Figure 3-10—Inside view of the MFJ-9020 CW transceiver. Extra circuit boards on the rear panel are an optional CW keyer and narrowband filter system. Photo courtesy MFJ Enterprises, Inc.

MFJ's 971 antenna tuner and 4112 power pack to produce the integrated setup shown in *Figure 3-11*. In this case, the complete 6 X 6.5 X 6.75 inch QRP station can be set up and operated in the woods or right on a beach. The only additional items you need for such on-the-spot QRP fun are a wire antenna and key. The portable antenna tuner matches dipoles, verticals, random wires, and balanced-line doublets. It has a built-in SWR meter and balun. The portable power pack has a 110 vac to 12 vdc power supply, plus 8 "D" cells can be loaded into it for stand-alone operation. Straps for combining the previously mentioned tuner and power pack with the 9020 transceiver are included with their respective units. I also understand that MFJ will soon produce additional models of this transceiver for other bands.

I recently quick-reviewed the MFJ-9020, and found it to be a rather impressive little rig. Using it in the early morning when 20 meters was just opening, I worked a number of good DX stations. It was quite enjoyable to find the internal speaker had plenty of volume for in-shack use. Selectivity was good, output was approximately four watts, and the rig easily fit onto a corner of my desk. Moving outdoors and

Figure 3-11—A full portable QRP station consisting of MFJ-9020 transceiver, antenna tuner, SWR meter and portable power pack. Photo courtesy MFJ Enterprises, Inc.

powering the MFJ-9020 from a Quantum "Ham Battery" also worked fine, and it was a refreshing change of pace. Performance was not in the same class as Ten-Tec's new Argonaut II, but neither was the MFJ-9020's price. If you are looking for a neat and economical go-anywhere QRP transceiver, the MFJ-9020 is a good choice. For more information contact MFJ Enterprises at the previously mentioned address, or telephone 800-647-1800.

The Heathkit HW-7, HW-8, and HW-9

Although the Heathkit "HW" QRP transceivers are no longer produced, used models continue to appear in hamfest fleamarkets, and they continue to be popular among QRP enthusiasts. Bearing those thoughts in mind, we present the following brief history of Heathkit's classics.

Figure 3-12—Meet the classic Heathkit HW-8. This 2.5-watt CW transmitter is an all-time favorite that continues to appear in hamfest fleamarkets. Photo courtesy of owner, Lindel Thiesen, AA7DG.

The Heath Company of Benton Harbor, Michigan was involved in QRP for many years, and their CW-only two watt transceivers can still be found in Amateur setups worldwide. These units performed relatively well, yet the number of modifications or *improvements* added by enthusiastic owners is inestimable. Indeed, it reminds one of the classic Hallicrafter S-38 Receivers in *owner expansions*. If you find an unmodified HW-7 or HW-8 today, feel fortunate! The Heath HW-7 was a basic QRP transceiver, utilizing direct conversion. A dual gate 40763 MOSFET plus audio amplifier stage is used for receiving, while the transmitter's VFO is also used for local oscillator injection. The RF output stage uses two MPSU-05 transistors in parallel. Semi break-in with CW sidetone round out the unit nicely.

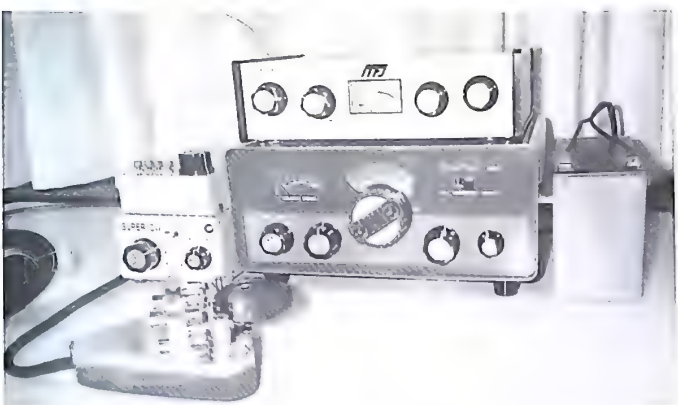


Figure 3-13—The latest and last of the famous "hot water" series from Heathkit: The HW-9. The unit is flanked by a gel-cell battery, keyer, and antenna tuner. Photo courtesy of N7HI.

During 1980, Heath introduced the HW-8. Thanks to a present owner and good friend, Lindel, AA7DG, a photo of an HW-8 (in actual use!) is shown in *Figure 3-12*. Like its predecessor, the HW-8 covers 80, 40, 20, and 15 meters. RF output is approximately 2.5 watts, and the improved receiver section has approximately 0.2 microvolts sensitivity. An audio filter, with front panel selection of "narrow" or "wide" bandwidths are included, plus the main dial is linearly calibrated. The HW-8 is a good CW transceiver, and capable of providing many hours of QRP operating enjoyment. Your author can attest to that fact. I worked over 100 countries with an HW-8 several years ago, and have the QSL cards to prove it.

The HW-9 is a complete rebuild of its ancestors. This unit covers the five popular HF bands plus the 30, 17, and 12 meter WARC bands, if a previous owner installed that option. Performance of the HW-9 is good but, like the HW-7 and HW-8, owner improvements are endless. In fact, nearly every issue of the *QRP Quarterly* magazine carries notes on improvements for Heathkit's QRP classics. These little critters defy fading in the annals of time, and they are a terrific way to have fun with QRP without taxing your budget. Thanks to my good friend John, N7HI, a photo of the HW-9 (set up with accessories for operation in a motel room) is shown in *Figure 3-13*.

Just as we were closing out the book, we received infomation on a brand new rig. The *Backpacker I* has just been introduced by **Tejas RF Technology**, 17 South Briar Hollow, Suite 101, Houston, TX 77027 (Telephone: (713) 840-8600). The new *Backpacker I* measures only 2.5 X 6.5 X 5.5 inches (H,W,D). For more information on this interesting transceiver, refer to the end of *Chapter 4*.

This chapter presented a brief overview of presently available and commercially manufactured QRP equipment for getting started in low power operation fast. When purchased new, commercially made equipment gives you the security and confidence of a good warranty and a loyal customer support program. Additionally, commercially manufactured equipment is usually more elaborate, and often performs better than homebrewed equipment. Some of us enjoy building gear, and some enjoy operating. Both groups have a definite place and serve a very meaningful purpose in our Amateur Radio world. Do your own thing, and enjoy QRP in the way best suited to your lifestyle!

Figure 3-14—While wrapping up this book, Tejas Technology's new Backpacker I transceiver arrived. As you can see, it is a real beauty.

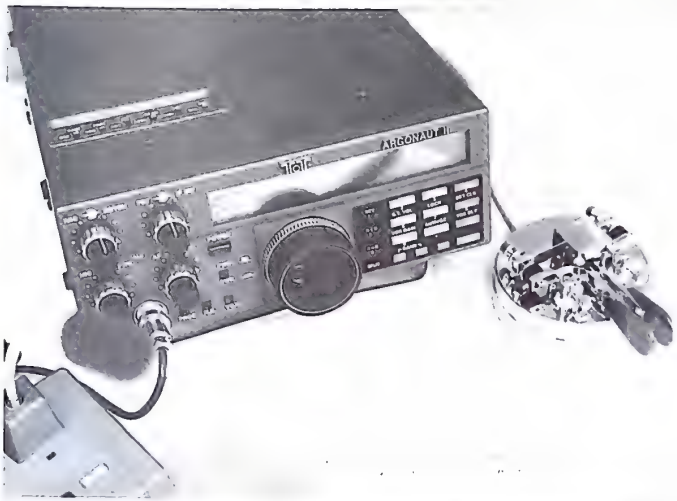


Figure 3-15—Ten-Tec's Argonaut II shown here is truely a serious QRPers dream rig. This modern do-everything transceiver continues a long-time tradition of going QRP in high style!

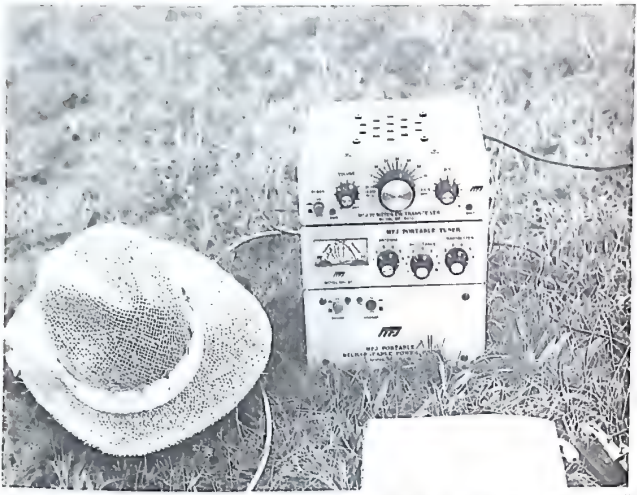


Figure 3-16—What do you get when combining a QRP transceiver, battery pack, small key, and roll-up antenna? A portable station you can operate anywhere and enjoy working the world from the great outdoors. Shown here is the MFJ-9020 QRP transceiver and triple-stack accessories for exactly that pursuit..

Chapter 4

Homebrew QRP: High Adventure At Low Cost

Half the fun of QRP is home-assembling low power gear for on-the-air operation. In fact, this chapter addresses that popular subject head-on! *Be forewarned, however.* If you're looking for exotic circuits and high performance designs comparable to professionally manufactured equipment, I must tell you up front—they're not here. Instead, we primarily spotlight simple and easy-to-build items for having fun on QRP. I say "primarily" because my enthusiasm often becomes uncontrollable and expands beyond basic one-or-two transistor transmitters. I will compensate for that diversion by also including a couple of classic vacuum tube QRP rigs to recapture the romance of eras past. This combination should result in something for everyone!

QRP homebrewing has many favorable aspects including low cost and high enjoyment. Hamfest-obtained parts, for example, can be carried in a pocket rather than filling the auto's trunk (and half the garage!). Likewise, a complete project can be packed into a small cigar box and carried anywhere for impromptu on-the-spot assembly (similar to a YL's knitting bag!). When initially building an unfamiliar circuit, I prefer to first assemble the unit on a plug-in experimenter's board like that shown in *Figure 4-1*. These boards are available from various Amateur dealers nationwide, and even appear in Radio Shack stores on an eclectic basis. Here are some additional tips for new homebrew enthusiasts. Even if you are using new parts, use your ohmmeter to check each one before including it in a project. Nothing is more frustrating than a circuit that does not immediately function, simply because an assumed good (because it was new) capacitor was shorted, a resistor opened, a transistor was bad, etc. Use a small iron (the little 10 watt jobs are ideal) and some very thin solder. Work under a magnifying glass if necessary. And, please, do remember to heat a junction until solder flows evenly. Never heat the solder and drop it onto the connection. This will cause a cold solder joint, which will prevent your circuit from working. After assembly, use your ohmmeter to check for proper connections.

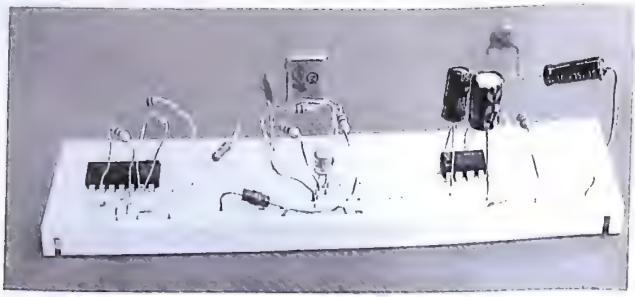


Figure 4-1—Readily available experimenter boards are perfect for test-assembling home-brewed QRP circuits. Components simply plug into holes that interconnect vertically on each side of a center isolation area. The three circuits shown here are: Half of a Two Chipper, the QRP Pen and an LM386 amplifier stage.

The best way to do this is as follows: First, place one ohmmeter lead on a resistor lead that's going to a transistor and the other ohmmeter lead on the transistor's wire. This way, you must measure through your solder joint. Next, move one lead to the opposite side of the resistor so you are measuring resistance plus your solder connection. Finished? First, visually check your wiring for errors. Look (hunt!) for something wrong, rather than simply confirm that you did everything right. This is a vital step. I learned through many years as an electronics instructor. The difference between my viewpoint and my students' viewpoint is that I strive to search for what is wrong rather than for what is right. If you follow the same procedure on your own circuit, errors are minimized. Finally, use your milliammeter, placed in series with the circuit's positive battery connection, to insure that the circuit is drawing current. Excessive amounts (like 1000 mA) or ridiculously low amounts (like 1 or 2 mA) usually indicate short circuits or open circuits, respectively. Move the negative milliammeter lead toward the positive milliammeter lead, one circuit component at a time until you find the wiring mistake. If your project has more than one stage, check for proper operation of each stage independently. Remember, one simple error can stop any circuit from working. Find it, and the unit may start to work immediately. One final tip: If all else fails, ask a friend to review your project. Many times a separate set of eyes will see obvious mistakes a builder sees—but overlooks—simply because they are too close to the problem. This is nothing to be ashamed of. We all make similar mistakes at one time or another.

If you enjoy homebrewing to any extent, I heartily encourage you to join the QRP ARCI and the G-QRP clubs which include a subscription to *QRP Quarterly* and *SPRAT* magazines, respectively. I quick-reviewed all issues of both magazines for the last three years while writing this chapter. I discovered that all issues are loaded with terrific QRP projects. Featured projects include receivers, transmitters, and transceivers. Some use transistors, some ICs, and some combine the two. Some produce one watt output, some a few milliwatts, and some projects are mini-linear amplifiers. To join the QRP ARCI, contact Mike Kilgore, KG5F, 2046 Ash Hill Road, Carrollton, TX 75007. The fee is twelve dollars per year membership. To join the G-

QRP Club, contact Luke Dodds, W5HKA, 2852 Oak Forest, Grapevine, TX 76051 (also 12 dollars membership per year). Another good club to join at this time is the Michigan QRP Club, P. O. Box 80804, Lansing, MI 48908-0804. Membership is seven dollars per year. I also heartily suggest contacting Bill Kelsey, N8ET, 3521 Spring Lake Drive, Findlay, OH 45840 and include a SASE for a catalog of Kanga US QRP kit/projects. As we will point out later in this chapter, Kanga's QRP kits are fantastic! Bill is also an outstanding individual dedicated to assisting other QRPers. Good luck to you in the world of QRP homebrewing. Now let's focus on the projects!

The K4TWJ *QRP Pen*

Our first project is a *just for fun* item with special appeal to new QRPers or experienced low-power operators interested in trying milliwatting. My *QRP Pen* shown in *Figure 4-2* is a 250 mW transmitter built into a slightly oversized (No Nonsense-type) ball-point pen case. The push-button on the cap's top is the key. Inside the case, there is a miniature 12-volt battery, full-transmitter circuit, and miniature HC-18/U crystal for 10.105 MHz. The transmitter works fine on 160, 80, 40, or even 20 meters. I simply prefer the QRP favoring-band of 30 meters. The antenna connection is on the bottom of the pen. I can connect the transmitter to an outdoor antenna for home use, or simply plug in a short wire for demonstrations. As an example, I can walk up to a transceiver on display at a hamfest or club meeting, tune it to 10.105 MHz, and begin transmitting to the rig. Needless to say, this little gem generates a lot of excitement every time it is shown. The amazement really rises when I explain the *QRP Pen* has worked several countries when connected to my home antenna. Build one of these little critters and install it in some unusual case to fit your fancy like a lipstick tube or small stuffed toy. Then surprise your upper class licensed friends at a local swap meet or Saturday morning dealer showroom meeting.

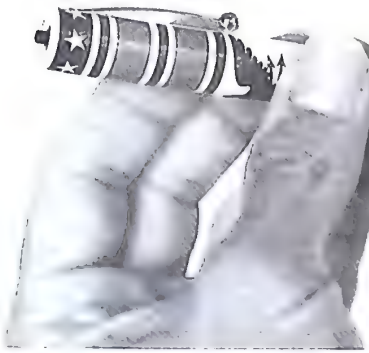


Figure 4-2—The K4TWJ QRP Pen. This device is a 250 mW transmitter complete with crystal control and miniature 12-volt battery. The push button on top keys the transmitter. The antenna connection is on the pen's bottom.

It is a true James Bond-type novelty. But do not underestimate its 250 mW signal. This pen transmitter has been used to contact Australia on 30 meters!

The *QRP Pen*'s circuit uses a single 2N2222 or 2N3904 transistor in a basic oscillator arrangement. The schematic is shown in *Figure 4-3*. Power is supplied by a tiny 12 volt cigarette lighter battery obtained from a jewelry store or Radio Shack. This battery is slightly smaller than a regular "N" 1.5 volt cell. By removing the battery's outer wrapper, it will slip into the cap of the pen. Use small wires for the top "key," that will slip beside the battery in the pen and hold everything securely by "wedging". The transmitter's circuitry is built *open air style* (no perfboard), and slipped into the pen's lower section. Be sure to wrap all wiring with tiny pieces of electrical tape and/or cotton to prevent short circuits. Use an Exacto knife to "whittle out" the case's lower section right at the point where it is threaded for the top section, and a small HC-18U crystal will then wedge into the junction. Be careful when reassembling the pen: Wires from the top key and battery can twist, wrap around the crystal's wires, and cause them to break. I used super small and flexible wire cut from a low cost Japanese earphone for this purpose. Alternately, you may wish to simply glue the top in place. Yes, I know this may call for a minor rebuilding when you replace the battery, but I have found battery life to be exceptionally good. In fact, with occasional use, it may last beyond a year!

Here are some additional tips. Use one-quarter watt resistors (or one-eighth watt if you can find them) and a small plastic-cased transistor. Also select low voltage capacitors, as they are smaller than regular components. If you do not plan to use this

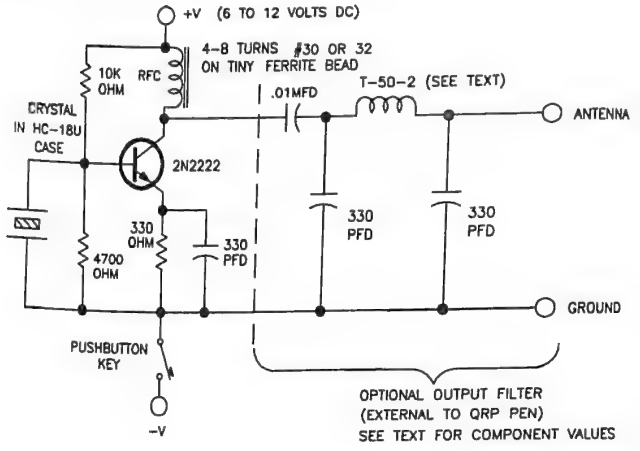


Figure 4-3—Circuit diagram for the QRP Pen. The output filter section is connected external to the pen.

transmitter with a large outside antenna, the output filter consisting of the toroid, dual 330 pF capacitors, and .01 mF capacitor (and even the Ferrite bead/RF choke) can be deleted. Alternately, you may prefer to include the ferrite bead/RF choke and assemble the output filter circuit externally so it can be plugged into the pen's antenna socket for "big-time" QRP use. The RF choke/collector load for the transistor is four to eight turns (as many as you can get) wound on a small (the smallest you can get!) ferrite bead. It is not critical. Notice there are three-330 pF disk capacitors in the complete transmitter. This resonates the unit on 30 meters. If you prefer 40 meters, change the three capacitors to 470 pF and add three additional turns to the toroid. For 80 meter operation, I suggest 680 pF capacitors and double the number of turns used for 40 meters. Two types of toroids can be used: The larger T-50-2 (14 turns of No. 22 or 24 enamel wire for 30 meters), or the smaller T-25-2 toroid (16 turns of No. 22 or 24 enamel wire). Crystals for this transmitter may be obtained quite rapidly by telephoning Jan Crystals at 1-800-JAN XTAL. Alternately, check your local Radio Shack for an 80 meter crystal. As this book is being written, Radio Shack carries tiny HC-18-case 3.58 MHz crystals for only $1.49. As soon as this book is completed, I plan to expand the little transmitter into a full transceiver. Looking at its circuit, I am confident a large-value resistor could be placed across the key and tapped to extract receive audio for amplification by a similarly simple circuit. The (added) high-value resistor would permit the oscillator to continue operating at a very low level (when the key is up). An incoming signal would then arrive at the 2N2222's collector, be detected and audio-heterodyned at its base/emitter junction. The resultant signal could be amplified for reception on an earphone. Closing the key would short out the high resistance (transmitter output increased to maximum), mute the receiver, and send a signal with full break-in operation. Ah . . . the fun of QRP experimenting is terrific.

KY8I's Michigan Mighty Mite

My good friend, Tom Jurgens, KY8I, recently described a neat little QRP transmitter which he built in only a couple of hours. It was so exciting, I could not resist probing further. Tom spotted the circuit in a past issue of the Michigan QRP Club's *Five Watter* magazine, snapped it together using available parts, and contacted several states. Obviously, a rig of that nature is too good to keep secret! A picture of Tom's Mighty Mite is shown in *Figure 4-4*, and its circuit diagram is shown in *Figure 4-5*. The transistor is a 2N3053, or common Radio Shack equivalent. Resistors are one-quarter or one-half watt, and almost any type of crystal will work fine in this circuit. A small 365 pF tuning capacitor salvaged from a defunct AM pocket radio is fine for tuning. The transmitter's coil is wound on a 35mm plastic film container (approximately 1.25 inches in diameter). Tom glued the film container to the perfboard for easy assembly. For 40 meter operation, the coil consists of 21 turns of No. 22 or 24 wire tapped at 7 turns. For 30 meters, wind 15 turns of the same size wire tapped at 4 turns. For 20 meters, wind 11 turns of the same size wire tapped at 4 turns. For 80-meter operation wind 46 turns and tap at 16 turns. For 160-meter operation, wind 64 turns and tap at 20 turns. The antenna pickup coil (L2) is 4 turns for 40, 30, or 20 meters, and 8 turns for 160 or 80 meters. Output of the transmitter is approximately 750 mW to 1.2 watts when powered from a 12 or 13 volt dc source.

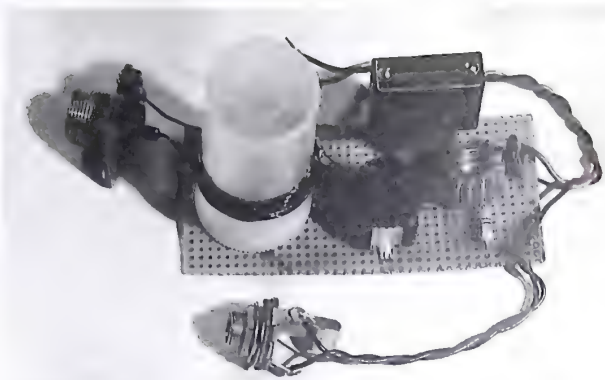


Figure 4-4—This is KY8I's Michigan Mighty Mite transmitter. The little rig utilizes a half-dozen parts and goes together in a jiffy. Do not underestimate its QRP ability, however. Tom contacted over a dozen states with the rig in only a few day's time after assembly. Photo courtesy KY8I.

KY8I's *MMM* shown here has yet to receive its attractive casing. Maybe some of our readers have clever ideas in mind for making it look like a real unique item. Who knows? Maybe we will see a QRP teddy bear, a ladies' egg-shaped hose container QRP transmitter, or a giant peanut that transmits with a one-watt signal. Use your imagination!

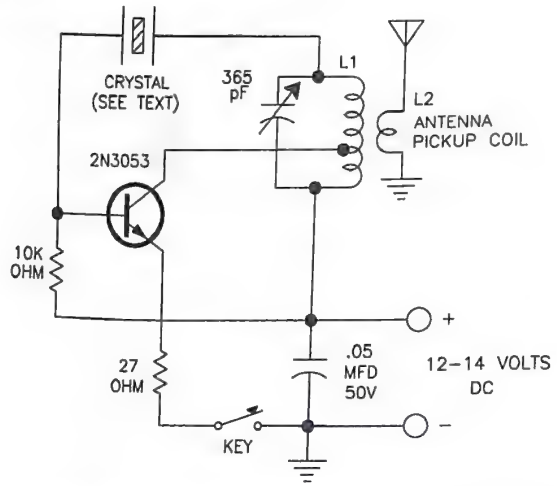


Figure 4-5—The circuit diagram of KY8I's Mighty Might.

N4DKD's *Four In A Row*

My good friend Brian Wingard, N4DKD, is continuously building QRP transmitters which utilize junk box parts. His *Four In A Row* rig, shown in *Figure 4-6*, is ideal for low-power enthusiasts with a limited budget. This transmitter utilizes ever-popular 2N2222s, and pumps out an impressive 1.5-watt signal on 30 meters. But there's more! This *Four In A Row* can also be assembled for operation on 40 or 80 meters, and the amplifier stage can be reduced to only 2 or 3 transistors if desired. Additionally, this concept of parallel connecting transistors can be applied to other types, like the popular 2N3053, to produce more output from conventional-design rigs, or to ensure an extra margin of high SWR safety when used with quickly-assembled antennas for camping.

A photo of N4DKD's *Four In A Row* transmitter is shown in *Figure 4-6*, and its schematic diagram is shown in *Figure 4-7*. Plastic-cased 2N2222 or 2N3904 transistors are used throughout. Resistors are one-half or one-quarter watt type, and the RF choke (left top corner of photo) may be any value from 50 to 100 uH. Brian used a Radio Shack No. 110-114 choke with all but 11 turns removed. A small trimmer or regular size variable may be used for the tuning capacitor. As an alternative, you could pretune the final circuit (adjust for maximum output with cleanest signal), then replace the variable with a fixed capacitor of small size. The two ohm resistors on each transistor's emitter ensure equal current for each device, and provides stabilization. Most standard crystals work fine in this circuit. If you are purchasing regular FT-243 types, request 32 pF load capacitance. The oscillator-to-amplifier coil is wound on a readily available T-50-2 toroid using No. 22 or 24 enamel wire. The primary is wound first, and its turns spaced evenly around the toroidal ring. The secon-

Figure 4-6—N4DKD's** Four In A Row **QRP transmitter. The positive lead of the 12-volt supply connects to the RF choke on the left side. The coax emerging from the board's right side connects to the antenna. Brian made several good contacts with this transmitter immediately after assembly and before mounting it in a case. Photo courtesy N4DKD.

dary is then wound over the primary with its turns also covering the full ring/primary coil. The number of turns on each winding is as follows: 30 meters-20 turns primary, 4 turns secondary, 40 meters-28 turns primary, 4 turns secondary, 80 meters-50 turns primary, 12 turns secondary. The output filter is also wound on a T-50-2 toroidal form as follows: 30 meters-14 turns, 40 meters-16 turns, 80 meters-24 turns. The filter capacitors on each side of the toroid are as follows: 30 meters-330 pF, 40 meters-470 pF, 80 meters-680 pF. Looking closer at N4DKD's *Four In A Row*, we see several additional points worthy of mention. First, several Amateurs have substituted basic capacitor coupling between the oscillator and final amplifier stage with good results. In this case, the oscillator transistor's collector is connected to the 22 ohm resistor/+v source by a simple RF choke (6 to 8 turns No. 32 wire threaded through a small ferrite bead), and inserting a 47 or 56 pF capacitor between the oscillator transistor collector and amplifier bases. Also, the oscillator's output signal can be tapped (point X in diagram), and used as an injection signal for a simple direct conversion receiver. In this case, the transmitter is easily expanded into a full transceiver. Additional details follow later in this chapter. The *Four In A Row* transmitter is an excellent way to get started in QRP at low cost. Try it: you will like it!

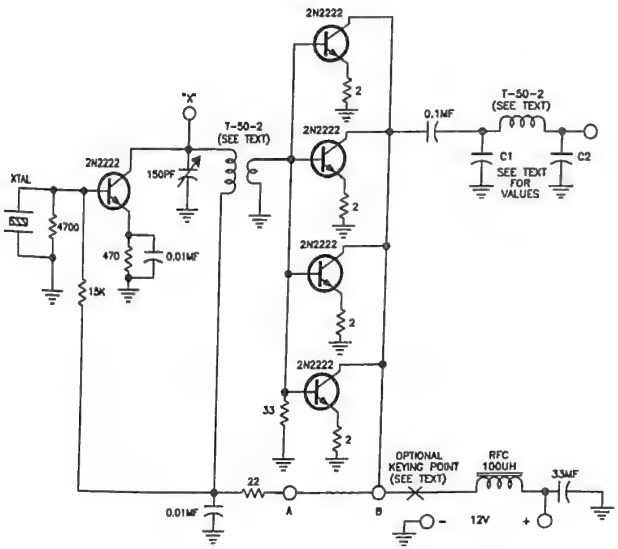


Figure 4-7—Schematic diagram of the Four In A Row transmitter. This concept of parallel-connected transistors can be applied to other circuits for increasing output and/or providing an extra margin of safety.

The *Two Chipper*

This tiny two-IC transmitter goes together in a flash, operates from a low current, five or six-volt battery, and delivers 250 mW of output for real QRPp fun. Study the schematic diagram shown in *Figure 4-8* and imagine how small you can make this tyke. Why, it could almost be a key fob! I am not sure who originally designed this circuit. It's been around many years and may be considered, well, generic. The oscillator consists of a standard SN7400 Quad AND Gate that drives a SN7403 Quad AND Gate with an output filter. Talk about a minimum number of parts! The same RF choke and output filter used in N4DKD's *Four In A Row* transmitter worked fine in this circuit. Simply use the values for your band of preference. If you like, you could also substitute a ferrite bead RF choke made by threading 6-8 turns of No. 30 or 32 wire through a small ferrite bead. If you'll look back at *Figure 4-1*, you'll see one stage of this transmitter on my home experimenter board. Yes, I have found new and surplus 7400s often defective, and "pre-testing" them in a mock-up circuit eliminates most troubleshooting. These ICs are designed to operate from a five volt source, but you can glue a thin metal strap on their top and increase voltage to 6 volts—but do not exceed 6 volts!

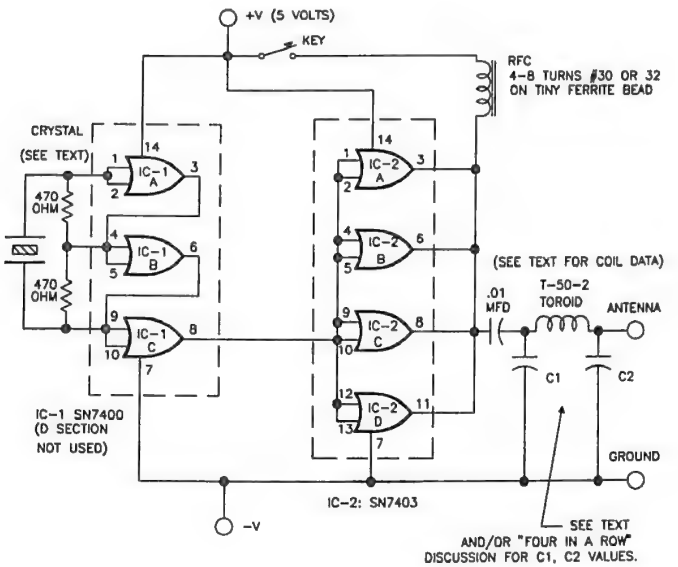


Figure 4-8—The Two Chipper transmitter uses an absolute minimum of parts. This genuine pocket rig requires only 5-volts dc for power.

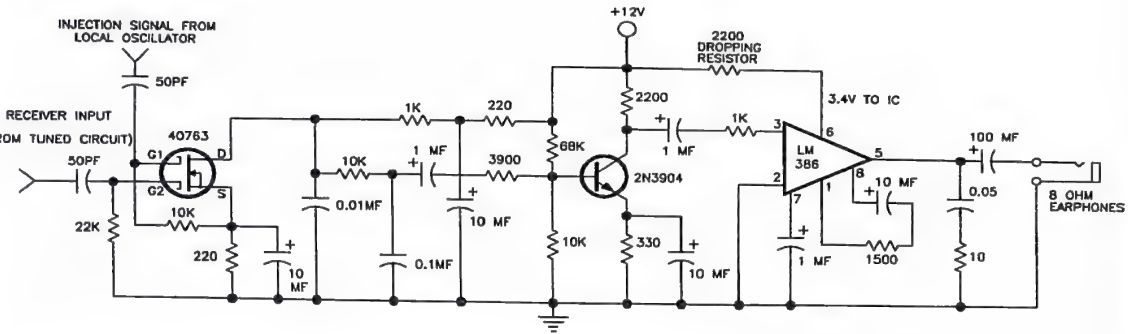


FIGURE 4–9

Figure 4-9—Schematic diagram of my direct-conversion receiver. This design can be combined with various transmitters to produce a full transceiver.

If you desire more output, the *Two Chipper* can be used to drive a two or four transistor amplifier stage like shown in N4DKD's *Four In A Row*. In this case, simply omit the output filter section and connect the 7403's output coupling capacitor to the bases of the 2N2222s (and apply 12 volts to the transistors collectors). You can also tap off the 7403's input (pins 1, 2, 4, 5, 9, 10, 11, 13) and add a 47 or 56 pF capacitor for an injection signal to drive a direct conversion receiver. This concept will produce a quite small, inexpensive and relatively effective pocket transceiver. A simple direct conversion receiver that can be used with the *Two Chipper*, *Four In A Row*, or *QRP Pen* will be discussed presently.

Expanding Your "Peanut Whistle" Into A Full Transceiver

Assuming you've assembled the *Four In A Row* transmitter or added its parallel connected 4-transistor amplifier stage to a *QRP Pen* or *Two Chipper* circuit, your work can be further expanded into a full transceiver with minimum difficulty. In this case, you simply add a direct conversion receiver and a full break-in antenna switching arrangement. Numerous designs of direct conversion receivers are popular, but the one I have found most useful is shown in *Figure 4-9*. This circuit is built around the inexpensive and easy-to-obtain 40673 MOSFET and an LM386 audio-amplifier IC. The circuit is straightforward and can be assembled on a regular perfboard using point-to-point wiring. The 40763 has two input gates: one connects to the transmitter's oscillator through a 50 pF capacitor (any value from 10 to 100 pF is fine here). The other gate usually connects to a tuned input circuit similar to that used in the transmitter's output filter, however I eliminated that section for simplicity. Instead, it connects directly to the antenna via a 50 pF capacitor and two "back to back connected" diodes for T/R switching. A sidetone circuit is not included, so the receiver is left unmuted during transmit. This produces a noticeable click/buzz in the earphones for monitoring your "fist." This receiver will copy any 80, 40, or 30 meter signal, as determined by its local oscillator/injection signal.

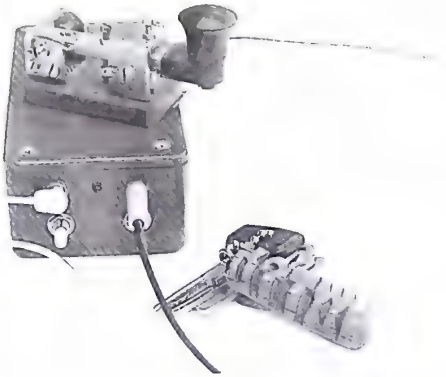


Figure 4-10—Author K4TWJ's pocketsize 30-meter transceiver ready for action. Note size compared to car keys and earphone.

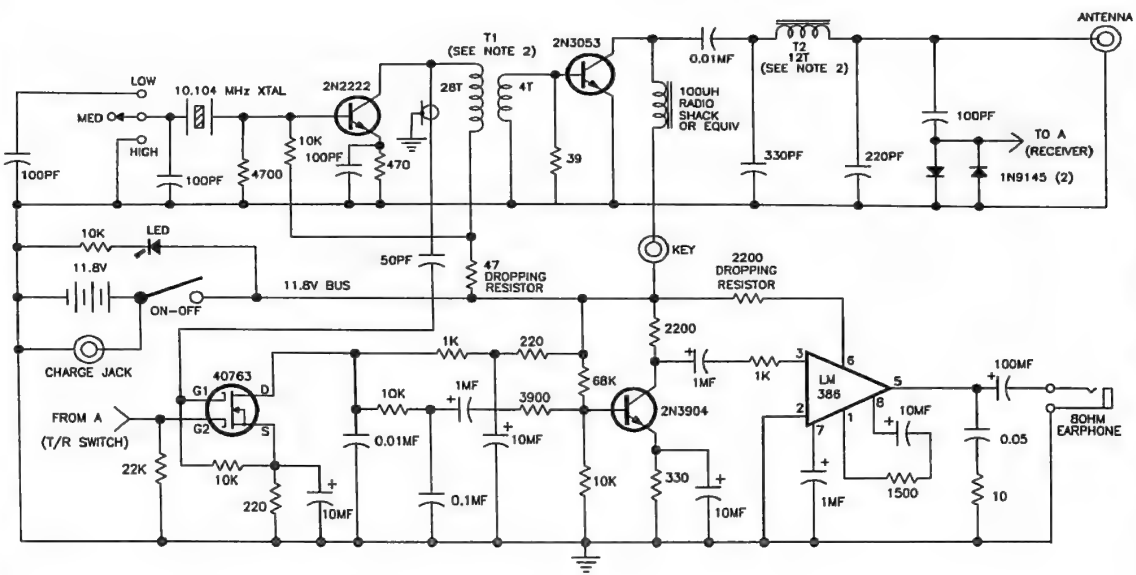


Figure 4-11—Schematic diagram of the K4TWJ pocket size 30-meter transceiver.

A couple of years ago, I coupled the previously described "bare bones" direct conversion receiver with a two transistor 1.5-watt transmitter, to produce a pocketsize 30-meter transceiver. This unit is shown in *Figure 4-10* , and its full schematic is shown in *Figure 4-11*. Notice that the transmitter's oscillator section is similar to the previously described *QRP Pen*, with switched capacitors for "warping" the crystal's frequency. The 2N2222s output is transformer coupled to a 2N3053 transistor, which uses an output filter circuit similar to N4DKD's "*Four In A Row*." The T/R switching diodes protect the receiver's MOSFET from RF overloading during transmit. This simple yet effective full break-in circuit is useful for RF power levels up to three watts. An inside view of my pocket transceiver is shown in *Figure 4-12*. The transmitter section is on the board's right side (closest to front panel switches), and the receiver section is on the left side. The board's black snap-on heat sink is affixed to the 2N3053, and is bent horizontally so everything will fit in the box. Look closely, and you'll see that the crystal is actually mounted upside down between the front panel's switches and jacks. The transceiver's board sits atop a rechargeable 11.7 volt battery pack, which was previously my spare for an early model Yaesu FM handheld. The transceiver is fully self contained and requires only an external antenna, earphone, and key for operation. I use this little 1.5-watt delight on an occasional basis, and have contacted over 20 countries with the rig. If you would like a simple yet effective miniature QRP transceiver, home constructing this unit (with any personally preferred modifications or expansions) is heartily encouraged.

Kanga Kits and The *Oner* Transmitter

There is a special pride and personal gratification in home-assembling QRP gear, but "starting from scratch" can prove challenging and time consuming. A more logical and attractive approach involves purchasing a ready-to-assemble kit complete with all parts and printed circuit board for can't-miss construction. You avoid all the hassles of hunting hard-to-find components, and save both money and time in the process.

One of the most impressive producers of QRP kits I have found is **Kanga UK** (3 Limes Road, Folkestone, Kent, CT19 48U, England), and its stateside representative Kanga US (Bill Kelsey, N8ET, 3521 Spring Lake Drive, Findlay, OH 45840). Kanga US is a one person company, and Bill does an outstanding job of importing and selling the kits plus offering general assistance to customers. Bill asked us to remind everyone that Kanga kits are not supplied with step-by-step Heathkit-type instructions like *connect yellow wire from point A to point* B, etc. but are more akin to a collection of components and information reprints from magazine articles. In most cases, Kanga kits are produced from the more popular transmitter, receiver, and transceiver articles featured in the G-QRP Club's magazine, *SPRAT*. As I have pointed out in previous chapters, this British group are real experts on QRP. Every issue of *SPRAT* is packed with terrific homebrew projects. Only a brief sample of Kanga's kits (those relating to the *Oner* transmitter and *Oner* transceiver) are highlighted in this chapter. A full catalog describing additional Kanga kits is available from N8ET (include a large SASE with two stamps for return postage). One of the most popular Kanga kits is the *Oner* transmitter, so named because it is a complete 3-transistor one-watt transmitter on a one inch square pc board. This transmitter was

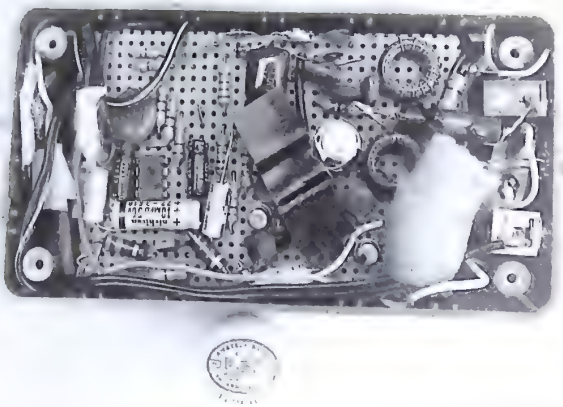


Figure 4-12—Inside view of the K4TWJ pocket-size transceiver. The crystal is wedged between the front-panel controls, with terminals upward. Warp capacitors below left-hand frequency selection switch. The heatsink on final amplifier (center of board) is bent horizontally so case top will fit in place. The rechargable battery is below the circuit board. This little critter is packed but it works great!

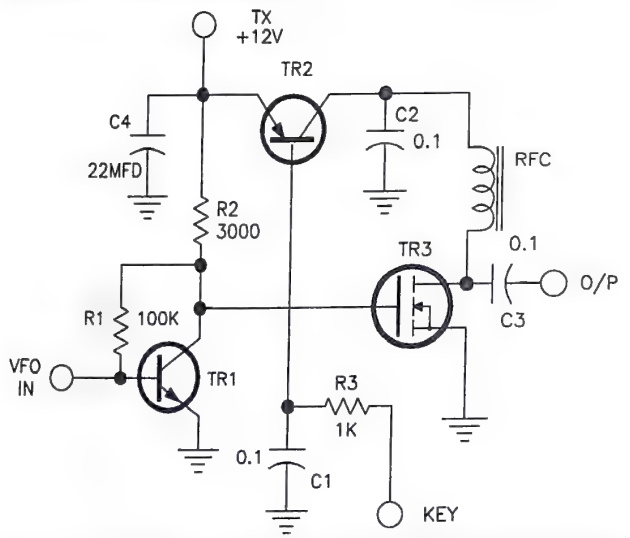


Figure 4-13—Schematic diagram of the popular Oner transmitter kit available from Kanga Products. This is one neat and super small QRP rig!

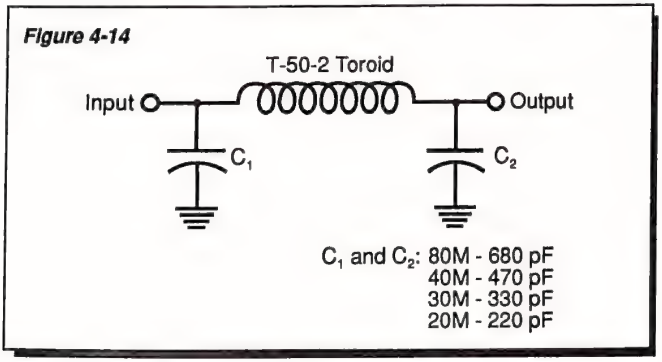


Figure 4-14—Schematic diagram of an output filter suitable for use with the Oner transmitter. It should work with other QRP rigs.

originally described in the Winter 1985/1986 issue of *SPRAT*, hundreds of these little gems have been built, and it is one of the most well known miniature transmitters in the world. The *Oner* transmitter schematic is shown in *Figure 4-13* for discussion. A British ZTX-621 bi-polar transistor oscillator drives a VN10KM power MOSFET to approximately one-watt output. The oscillator stage runs continuously, and the MOSFET is keyed by a British ZTX751 transistor. The RF choke is best assembled under a magnifying glass, as it consists of approximately 6-8 turns of No. 32 wire (supplied) threaded through a rather small ferrite bead. Assuming you use a small 10 or 15-watt soldering iron, thin solder, and work in a well illuminated area, the *Oner* can usually be assembled in an hour's time. An output filter should be connected externally to this transmitter and it is not supplied with the basic kit. A suitable filter is shown in *Figure 4-14*. This is exactly like the filter used in N4DKD's *Four In A Row* transmitter. The toroid is a T-50-2 wound with No. 26 enameled wire. Wind 12 turns for 20 meters, 13 turns for 30 meters, 14 turns for 40 meters, or 21 turns for 80 meters. The value of both capacitors used in this filter are as follows: 210 pF for 20 meters, 330 pF for 30 meters, 470 pF for 40 meters, and 750 pF for 80 meters. I have tried a variety of crystals in the Oner, and they all work fine. The first *Oner* I assembled did not work because I installed the oscillator transistor (TR-1) and keying transistor (TR-2) backwards. These are British transistors, so heed this important note for first-time success: Install TR-1 on the pcb so its round side faces TR-3. Install TR-2 so its round side faces away from TR-3 and its lettered side faces TR-3. A photo of the *Oner* Transmitter Kit as received from Kanga US is shown in *Figure 4-15*. The other three Kanga kits are the *Oner* Receiver, *Oner* VFO, and *Oner* Antenna Changeover Unit. These items will be discussed presently.

A picture of my first-assembled *Oner* transmitter (with substitute transistors for TR-1 and TR-2) is shown on the left side of the rig shown in *Figure 4-16*. Unfortunately, my enthusiasm outpaced my camera lens and I combined a homebrew receiver with the *Oner* Transmitter before shooting this photo. The receiver section

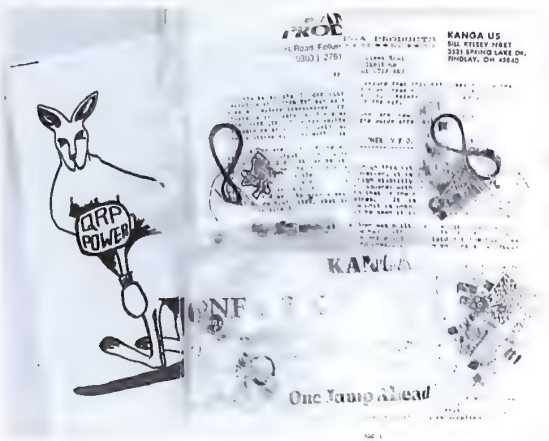


Figure 4-15—The Oner transmitter, receiver, VFO and atenna changeover kits as received from Kanga US. Each unit is packaged separately and includes all components plus information sheets on assembly. Transmitter package is at the left top. QRP Power is Kanga's catalog. Really inspires you to whip out the ole soldering iron, eh?

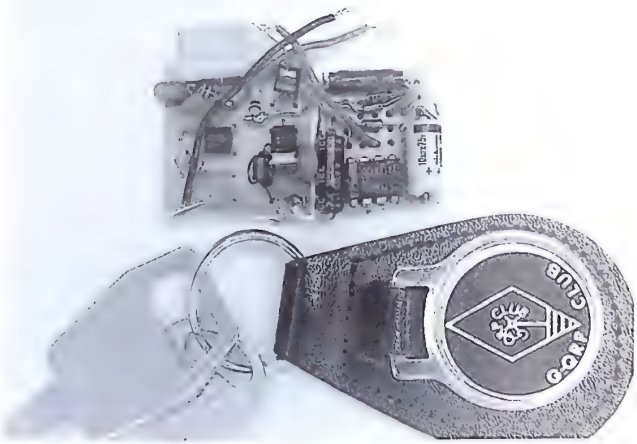


Figure 4-16—Author K4TWJ's Oner transmitter (left) combined with a homebrew receiver. The unit measures only 1 X 2 X 1 1/2 inch and really works. The photo was shot before I installed the rig in a plastic box and added connectors for key, antenna, etc. The car keys are included as a size reference.

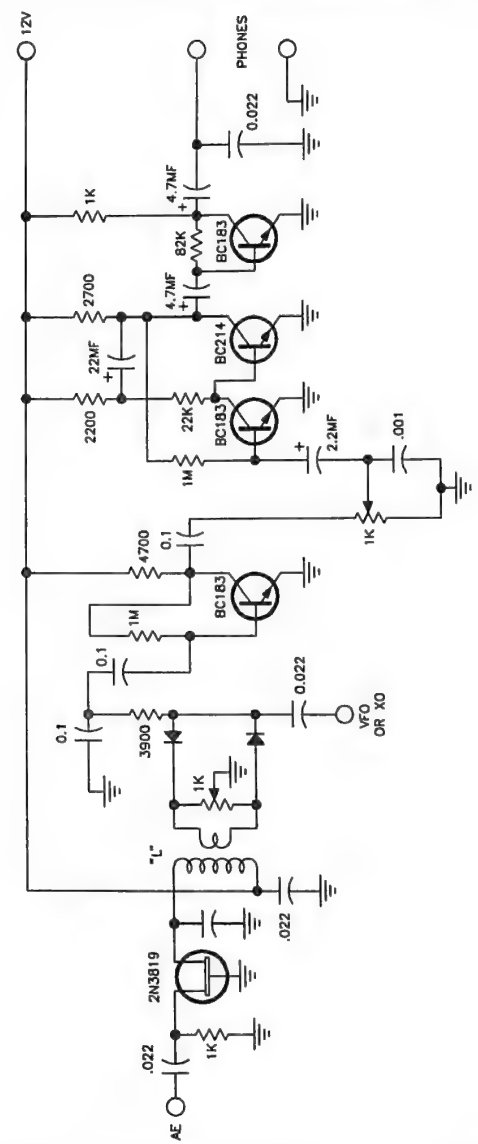


FIG 4-17

Figure 4-17—Schematic diagram of the Oner receiver kit from Kanga. An impressive five-transistor rig fits on a one-inch square pc board. Incredible!

uses a simple diode detector/mixer driving an LM386 audio amplifier stage. Two additional diodes are used for full break-in T/R switching. An extremely small pickup loop is wound over the transmitter's output coil (a one of a kind component) for the receiver input. Sensitivity and selectivity is only fair, and I hesitate to recommend duplication. Just build the *Oner* transmitter and combine it with the *Oner* receiver. That combo works fine!

The *Oner* Transceiver

Although the *Oner* transmitter may be purchased independently, the urge to purchase all four kits and build the complete transceiver is irresistible. Indeed, imagine all the ways you can lay out these four one-inch square boards to make a unique rig! The *Oner* receiver is a direct conversion unit with five transistors (schematic diagram in *Figure 4-17*). It has an FET RF amplifier section followed by a diode detector and four stages of audio amplification. Squeezing all components on a one-inch square board is quite challenging, and several connection points are on the top of vertically mounted resistors. If you are not proficient in home construction, start with the *Oner* transmitter before building this sophisticated little gem.

The *Oner* VFO was designed to operate with the *Oner* transmitter and receiver. However it is easily applicable to other homebrew transmitters or direct conversion receiver projects. The VFO uses a FET oscillator, loosely coupled to a two-transistor wideband amplifier. Output is approximately 5 mW across a 50 ohm load. This unit

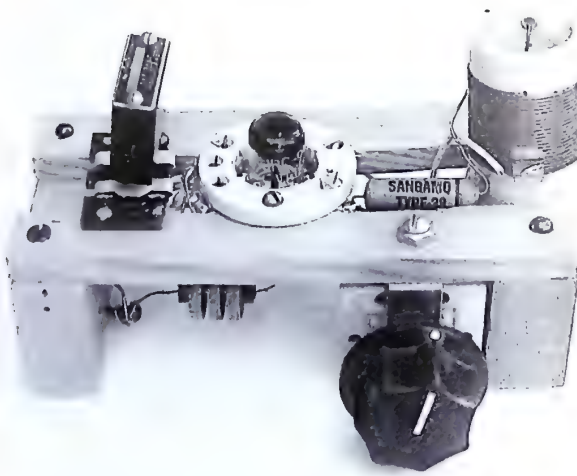


Figure 4-18—The QRP Acorn transmitter. This little heartthrob pumps out an impressive 500 mW of power. Several types of tubes can be used in this rig.

is not as "squeezed" as the receiver, and home assembly is quite easy. The *Oner* antenna changeover unit contains an antenna switching relay with an extra set of contacts for switching + voltage between transmitter and receiver. It also has a sidetone oscillator for monitoring your fist. A block diagram showing all *Oner* kit interconnections was included in *SPRAT* for Autumn 1988. This information, plus details on additional Kanga kits is available from Kanga US If you want to have a ball in QRP construction, get "Kanga'd". Their projects are great!

The QRP Acorn

Heads up classic rig enthusiasts—here is a warm and soft glowing little transmitter guaranteed to put some real romance in your QRP life! This little treat uses a popular 955 Acorn tube to deliver 500 mW of DX-grabbing power on the 30, 40, or 80-meter band. A photograph of our *QRP Acorn* transmitter is shown in *Figure 4-18*, and its schematic diagram is shown in *Figure 4-19*. Although the unit can be assembled in a metal box or card file box, I opted for a wood frame to resemble a miniature version of my first transmitter (a single 6L6 vacuum tube unit built on a similar wood frame approximately four times larger). Almost any type crystal works fine in this circuit. The one shown is a classic Bliley crystal for 7.040 MHz. The socket was made from a pair of RCA phono connectors obtained at Radio Shack. The 955 tube and socket were included in a small aircraft beacon transmitter obtained from Fair Radio Supply. This tube is often found today in hamfest fleamarkets. Alternately, you may substitute other miniature tubes like the 3A4 or 3S4. In this case, simply connect the tube's screen grid and plate together (at tube socket pins). The RF choke is a standard National item secured from a hamfest fleamarket. The plate/antenna coil is wound on a 1.25 inch OD form (another fleamarket spe-

Figure 4-19

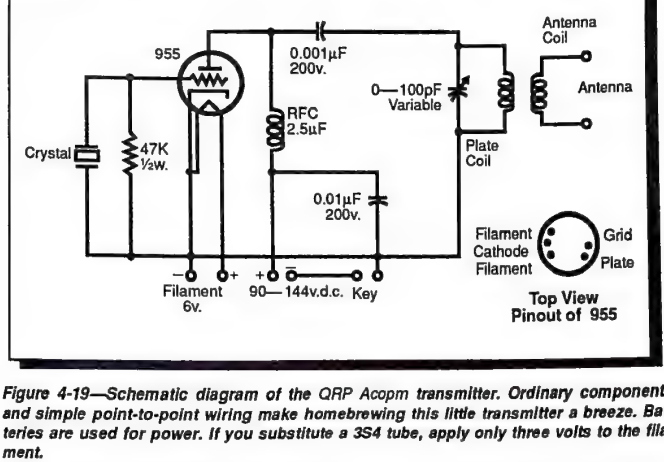


Figure 4-19—Schematic diagram of the QRP Acopm transmitter. Ordinary components and simple point-to-point wiring make homebrewing this little transmitter a breeze. Batteries are used for power. If you substitute a 3S4 tube, apply only three volts to the filament.

cial). The coil is wound with No. 22 enamel wire. Approximately 30 turns are used for 40 meters, 32 turns are used for 30 meters, and 55-60 turns are used for 80 meters. In all cases, the antenna coil is 8 turns wound below the plate coil. The 100 pF variable is a small open-air Hammarlund-type obtained at a hamfest fleamarket.

Rather than building an AC supply for this little transmitter, I prefer operating it from batteries (perfect DC and a beautiful, clean note). I use 10 regular 9-volt batteries "snapped together" in series to produce 90 volts. A small dry-cell battery is used for the filament. Current drain is quite low, and battery life is exceptionally good. If you are fortunate enough to find two 955 Acorn tubes, they may be parallel-connected to run down the batteries a little faster and produce one watt output.

Tune-up of the *QRP Acorn* is a cinch. Simply adjust the tuning capacitor for maximum output and cleanest signal. If desired, you can add an additional tuning capacitor (365 pF) in parallel with the antenna pickup coil for loading the transmitter. But do not go "overboard"—10 mA is maximum! The *QRP Acorn* is a blast of fun to use on the air, especially when teamed with a classic receiver from eras past. I have made many QRP contacts with the *QRP Acorn* and it now sits proudly in my windowsill awaiting more on-the-air action when this book is completed. I hope you have as much fun with your *QRP Acorn* transmitter as I have had with mine.

The Transformerless Wonder

This golden oldie from yesteryear introduced many aspiring young Amateurs to the world of QRP. It is unique, in that it utilizes a single vacuum tube and operates directly from the 115 volt AC line. The secret is a 117N7GT tube which is a combination oscillator/transmitter and rectifier. I must add an important note of caution up front. This is an *AC/DC* circuit. **Do not build this on a metal chassis!** Also, do not use it with a metal based key or any key where you can come in contact with metal parts while touching your receiver. Fair enough? Good. Now look at the transmitter's schematic shown in *Figure 4-20*. Notice one "side" of the AC line is used as "ground". When used with a similar AC/DC receiver, there is a 50/50 chance that 115 volt AC will be present between the key and the receiver cabinet. Ah—the fun of those good ole days! If you feel a mite intimidated, simply insert a small isolation transformer between your AC outlet and this transmitter. Shock hazards to ground will then be eliminated but yyou will still find about 150 vdc on the tube elements. The 117N7GT is becoming scarce today, but new and unused "bottles" can be obtained in hamfest fleamarkets. They are not cheap, but such is the cost of true nostalgic bliss! The original antenna coil used in this transmitter was a standard plug-in receiver coil for the 80 or 40-meter band. These items are now "rare as hens' teeth," but you can homebrew a coil form by gluing a tissue roller tube to a salvaged 4-pin tube base or simply mount the tissue roller on the transmitter's (suggested) wood form. In other words, any 1.5 to 1.75 inch OD form will be fine for winding the coil. The coil is wound with No. 22 enamel wire spaced to occupy approximately two inches length on the form. Wind 12 turns for 30 meters, 15 turns for 40 meters, or 22 turns for 80 meters. The tuning capacitors may be regular "open air" 365 pF variables salvaged from an old (tube model) radio. Alternately, 150 pF *open air* variable capacitors may be used.

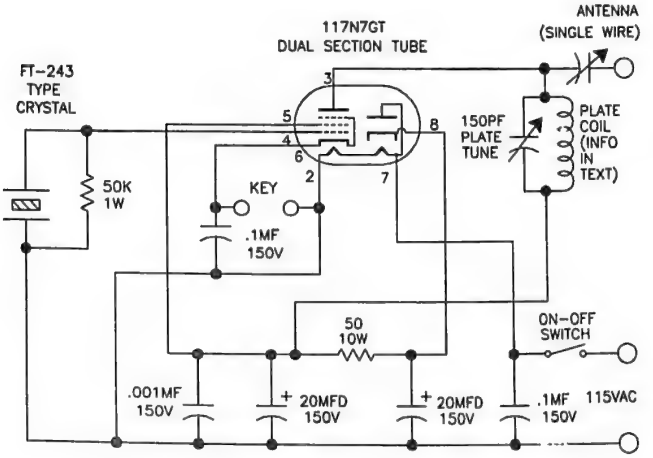


FIG 4-2D

Figure 4-20—Schematic diagram of the Transformerless Wonder transmitter. A classic 117N7GT tube is used in this delight of yesteryear.

Tune-up of the completed one-tube transmitter is relatively straightforward. After ensuring that all wiring is correct, plug in the line cord and allow the tube to warm up for five minutes. This extended and initial warmup brings the tube back to life and allows all the nostalgic big band sounds of the '40s to dissipate from its grids. Next, close the key and tune the plate capacitor for minimum current/maximum output. The old-timers call this "tuning for maximum smoke." The transmitter should draw approximately 25 mA of current. You can then adjust the antenna loading capacitor (while retuning the plate capacitor for minimum current/maximum output) until approximately 30 mA of current is drawn. At this time, the transmitter will be fully loaded and produce about 2-watts output. If you don't use an isolation transformer, remember to keep your hands out of this circuit and off the key's metal parts during operation, and enjoy old-time QRP in high style!

While in the process of concluding the writing of this chapter, I received a neat PC board for a QRP transceiver originally presented in November 1990 *73* magazine. The pc board was produced by **FAR Circuits**, 18N640 Field Court, Dundee, IL 60018. Another QRP project is standing by for construction! This one is definitely

Figure 4-21—Another QRP project hits the bench! The PC board is produced by FAR Circuits of Dundee, IL. Other components ready to be installed were obtained at a Radio Shack store.

going to be fun (see *Figure 4-21*). Looking through FAR Circuits' information, I see they produce pc boards and complete kits for a large number of QRP projects described in past issues of *73*, *QST*, and *CQ* magazines. They are really neat projects! Drop FAR Circuits an SASE for information. I am sure you'll like what you receive in return.

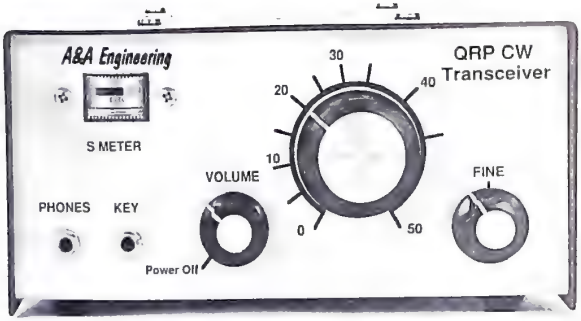


Figure 4-22—This A & E Engineering QRP high performance rig has semi-break in, adjustable side tone, and is available for 40, 30 or 20 meters. Photo courtesy of A & E Engineering.

Flash! Information on the new full QRP transceiver kit available from **A & A Engineering** also just arrived. I am sure you will appreciate knowing about this little tyke, so here are the details. This transceiver first appeared in December 1990 and January 1991 *QST*. A & A Engineering now makes it available in a full kit or semi kit consisting of pc boards and various parts. For specific details on the rig, contact A & A Engineering, 2521 W. LaPalma, Unit K, Anaheim, CA 92801, telephone (714) 952-2114. A picture of the A & A transceiver is shown in *Figure 4-22* and an inside view of the rig is shown in *Figure 4-23*. The transceiver is built on two circuit boards, each measuring approximately 5 X 3 inches. The complete rig is housed in a cabinet measuring 3 X 6 X 7.25 inches. Everything you see is included in the rig, right down to the nuts, bolts, and prepunched plus labeled enclosure. The receiver is quite elaborate, with a sensitive front end, audio derived AGC, and 400 Hz crystal filter. The transmitter delivers five watts output, has adjustable sidetone, and semi break-in that is adjustable from several seconds to almost full QSK. This transceiver is available in three single-band models for 40, 30, or 20 meters. If you would like to get started in QRP with a neat rig and enjoy saying "I built it myself," A & A's all-in-one kit seems like a good choice. Check it out!

The Tejas Backpaker I QRP Transceiver

The good news keeps on coming! As we wrapped up this QRP book and began its Index, details on another QRP transceiver kit arrived and it really looks fantastic! The new *Backpacker I* has just been announced from **Tejas RF Technology**, 17 South Briar Hollow, Suite 101, Houston, TX 77027 (Telephone: (713) 840-8600). The new *Backpacker I* measures only 2.5 X 6.5 X 5.5 inches (H,W,D), and you can

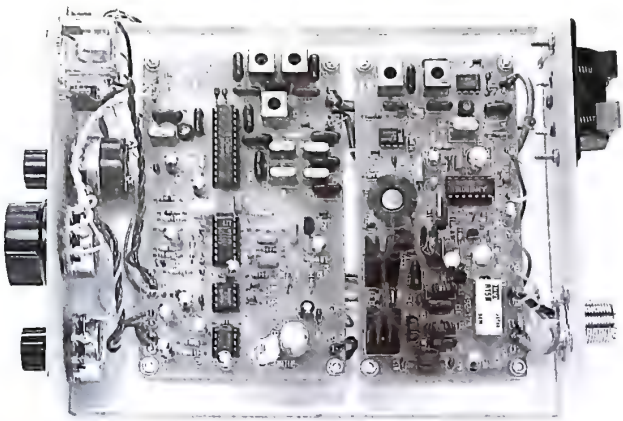


Figure 4-23—Inside view of the A & E Engineering transceiver. Unit is available in kit form and is relatively easy to assemble. Photo courtesy of A & E Engineering.

assemble it for operation on 40, 30, 20, 17, or 15 meters. I understand in-field modifications to change bands is quite easy. This "little gem" is first class all the way and includes full break-in with no relays (extremely smooth), RIT with center-detent control, selection of three bandwidths, vernier reduction drive tuning, and rugged case built to take outdoor life in stride. The transceiver is based on the famous *W7EL Transceiver* described in *QST* some time ago, but Tejas has added many new additions and features. The rig covers 200 kHz of any desired band, utilizes times sequence differential keying, and loafs along at two-watts output. A hefty 2SC799 transistor used for the final amplifier. High SWR protection is also included. Tejas sent over a model and I checked it out while completing this book. The results were terrific! The receiver was extremely sensitive, and its front panel selection of various bandwidths made CW reception delightful. Break-in operation reminded me of Ten-Tec—top quality. I made a number of good DX contacts with the Backpacker I on 30 meters, (3B8CF on Mauritius Island was my first QSO—honest!) and have absolutely no reservations in recommending it as a great QRP rig. The Backpacker I is a fully complete kit including all parts, enclosure hardware, and instructions. It also qualifies for the "homebrew" category of contests. Additionally, fully assembled and tested models of the Backpacker I are available if you do not have time for homebrewing. A photograph of the Backpacker I is shown in *Chapter 3*. For more information on the Backpacker I, contact Tejas RF Technology.

Half the fun of homebrewing is assembling small transmitters, receivers, and transceivers. I trust you found some of the circuits presented in this chapter appealing and I certainly wish you all the best of luck and success in building your own QRP gear.

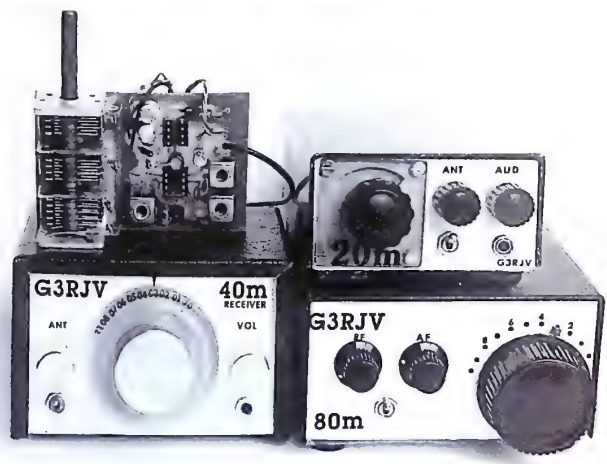


Figure 4-24—These neat and easy-to-assemble transmitters and receivers are readily available in kit form, and quite easy to assemble.

Chapter 5

Impressive Station Accessories For QRP

Want to add some extra fun to your QRP activities and make them a real blast? Combine some neat accessories with your home or portable setup and make it a miniature dream station. This concept is really delightful for low-power rigs. Most items are small enough to pack into a travel bag, relatively low in cost, and their extra touch of *personal expression* makes QRPing impressive from any standpoint.

Consider, for example, the simple fun you can enjoy with a special hand key connected to your portable QRP transceiver. Making contacts with very low power is often more successful at slower CW speeds because dots (and dashes) are on the air long enough to be discerned rather than being lost in band noises.

You can also vary *weighting* and *speed* according to conditions and signal reports: A definite advantage when you are milliwatting! This does not mean you should put your electronic keyer (and microphone) aside and ignore them, however. Indeed not: They will see plenty of hot action when band conditions are good and/or during contests.

Speaking of "action," here are two tips to keep in mind. *Increasing the weight control* on your electronic keyer will make your low power signal more readable over long haul paths, and *using a good speech compressor* will give your signal more talk power and punch when using SSB.

Additional station accessories are limited only by your preference and imagination. You can add antenna tuning items to help ensure that all your available power is coupled to the antenna. You could also include SWR meters and wattmeters, a cassette recorder for taping special contacts, and much more. Let's now take a closer look at some of the previously mentioned accessories to inspire your own creative thinking.

Figure 5-1—G4ZPY's new ultra-miniature hand key is the ideal mate for a pocket QRP rig. This little delight is incredibly small (compare size to the ruler in photo) and it works great. Photo by K4TWJ.

Terrific Hand Keys

Did you notice some of the miniature keys I used with pocketsize rigs in previous chapters? These little "critters" really make portable operation a novelty, but finding even one is a super challenge. They are rare as "hens' teeth!" There is one exception and to the best of my knowledge, it is the only miniature produced in the world today. The **G4ZPY Miniature Key** shown in *Figure 5-1* measures only one-inch square, it really works, and it is available at a fair and square price from Gordon Crowhurst, G4ZPY, 41 Mill Dam Lane, Burscough Ormskirk Lancs, England L4 7TG. Gordon makes these jewelry-like gems by hand. There may be a waiting list, but it is worth every bit of time and finance invested. Indeed, this is the world's smallest operational key in production today!

The working parts of this little marvel are solid brass, painstakingly polished to the luster of sheer gold. They are set on a mahogany-looking base, with a thin felt cushion on the bottom. The key pivots in the center, tension is adjusted by the rear knurl screw, and spacing is adjusted by releasing the locknut/skirt while rotating the knob for a desired gap. Keying wires connect to the two tiny binding posts on each side. Although incredible small, the key handles good up to approximately 10 words per minute. You may simply prefer to wear the key on a neck chain (like that used for holding reading glasses) while attending a hamfest. It is definitely an attention grabber.

If you prefer a more luxurious and full-size pumper, G4ZPY's 22 karat gold **Trophy Model** key shown in *Figure 5-2* may prove to be more appealing to you. If you prefer a more conservative key, this same style/model is available in silver or nickel plate, or in a conventional brass movement (with mahogany base) at a quite reasonable cost. The latter item can also be purchased in "kit" form (actually 75 percent preassembled). I have found all models of G4ZPY's keys to be absolutely superb

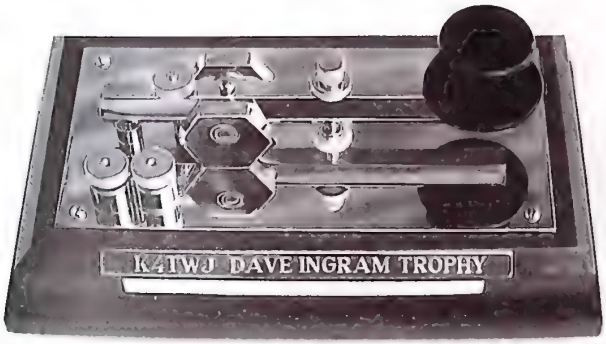


Figure 5-2—The luxurious 22kt gold Trophy key available from G4ZPY. This spectacular item adds 3 dB to QRP enjoyment!

(otherwise I would not be telling you about them here). They handle great, and every one of the hand/pump models has a classic "click-clunk" report (just like old-time telegraphy) during use. They really make *plain-style* CW fun. Drop G4ZPY a letter with two IRCs for more information on his keys and paddles.

Another impressive hand key is the **Champion** item shown in *Figure 5-3*. This key is handmade by Schurr in Germany, and available from Klaus Gramowski, DL7NS,

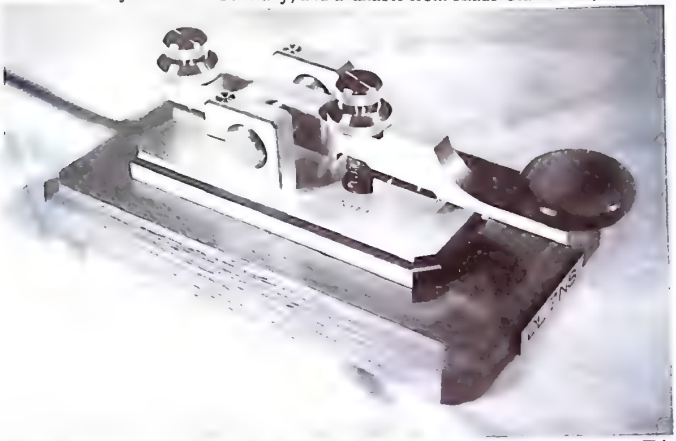


Figure 5-3—Handcrafted Champion pump key available from DL7NS in Germany. This magnificent key features highly polished brass workings and a mahogany base.

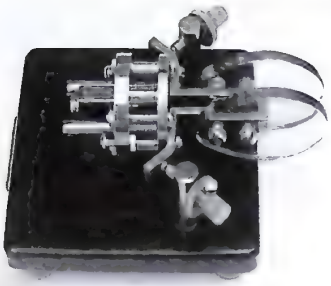


Figure 5-4—The hand-crafted VHS Iambic paddle made and sold by G4ZPY. The paddle is extremely impressive with brass polished to the lustre of fine gold and silver screws.

Kaiserin-Augusta-Allee 91, D-1000, Berlin 10, Germany (telephone 030 344 7826). The Champion key measures approximately 7 inches long by 3 inches wide, and is solid brass with highly polished finish and *Zapperung* coating for long life. It is absolutely a precision built key, with a center fulcrum and separate adjustments for tension and gap/spacing. The knob is cherry wood, and a felt pad is included on the bottom of the key. For more information on this key, drop a note with two IRCs to DL7NS.

A vast number of hand keys are readily available today, and including them all in this chapter is, naturally, impossible. I thus spotlighted some of the more unique hand keys to "spice up" your life with some "new directions views." Enjoy!

Unique Paddles and Keyers

If your taste and preference lean more toward ultra modern paddles, check out G4ZPY's unique **VHS Iambic** shown in *Figure 5-4*. This hand-crafted masterpiece has brass parts with silver screws mounted on a black base, and it has the glitz of Beverly Hills jewelry. Like all G4ZPY keys, contacts are silver-to-silver. Notice the

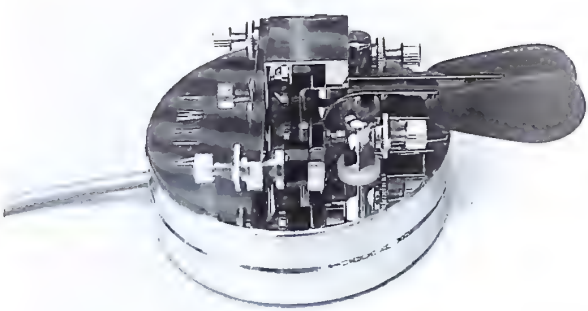


Figure 5-5—The one-of-a-kind Mercury paddle made by N2DAN/4. This incredible masterpiece weighs four pounds, sports triple chrome plated mechanism and has rodium contacts to last a lifetime. The ultimate paddle for QRP and QRO.

extra-thick dot/dash arms and fingerpieces: this paddle is made for heavy duty use and high speed operation indeed! *It takes a whammin' and keeps on hammin'!* Looking at the key from the rear, it also looks like a miniature Gatlin gun—a genuine conversation piece. I have used many paddles, but this one tops them all.

If you need a small stand-alone keyer, that item is also available from G4ZPY. The keyer is exactly the same size as the VHS paddle, approximately 3/4 inch high, and slips right under the key. In this case, curved fingerpieces are also available for making the unit a stand-alone "combo." Alternately, you can simply attach the keyer to the back of your rig with double-sided tape. The G4ZPY keyer is particularly interesting in its selection of automatic inter-character spacing when sending CW—a good feature when you switch between single or dual lever paddles. Space precludes describing additional models of G4ZPY paddles (both dual and single lever), but I am proud to give you a glimpse of these impressive keys/paddles.

The paddle shown in *Figure 5-5* is strictly for total CW connoisseurs. This one-of-a-kind item is handmade by Steve Nurkiewicz, N2DAN/4, 1385 Abner Street, Port Charlotte, FL 3398. This paddle is named the **Mercury**. It is made of solid brass (four pounds worth!), triple chrome plated (a dazzling luster), and uses magnets instead of springs for tensioning. Do not compare the Mercury with *any other* magnet-type paddle you have ever seen. There is absolutely no comparison. In fact, there is no comparison between the Mercury and any other paddle! The arms are super thick, set into precision bearings, and the contacts are silver with rhodium plating. The Mercury is built to last at least two lifetimes, and will key anything from an electronic keyer to a microwave oven! This key is so unique, most owners include them in their will! The Mercury is not inexpensive (neither is champagne and caviar), and there is usually a waiting list, as Steve is retired and makes these modern-

Figure 5-6—The famous Heil HM-10 microphone is known worldwide for its superb quality and high talk power when combined with modern SSB transceivers.

day collectibles on an *as time permits* basis. If you demand only the best of the best, however, drop a note with an SASE to N2DAN/4 for more details.

Microphones and Speech Compressors

If SSB is your operating preference for QRP, a good microphone and speech compressor really make the difference. A top item I have found in this area is Bob Heil's microphones and elements for microphones. Heil's most popular microphone is the HM-10 shown in *Figure 5-6*. This microphone is available with a full-range element (HC-5) or a high frequency-pitched HC-4 DX element that really delivers a punch. The Heil elements are also available separately for retrofitting into your microphone case. Additionally, preassembled microphones and cable sets that plug directly into most modern transceivers are available directly from Heil.

Extra articulation and talk power produced by using one of these elements will make your SSB signal stand out like a shiny new car on a dirty freeway. The difference between this microphone and a "stock" mic supplied with most transceivers is daylight and dark! For more information on the Heil microphones, elements, and headsets with boom mic, contact Heil, Ltd., No. 2 Heil Drive, Marissa, IL 62257.

The MFJ SWR Analyzer. This stand-alone unit is ideal for tuning and adjusting antennas right "on the spot." Photo courtesy of MFJ Enterprises, Inc.

Antenna Tuning Items

Whether your antenna system is a simple dipole or an elaborate multi element beam, fine tuning it for top performance has a decided advantage for QRP operations. This usually involves adjusting the antenna for lowest SWR in the band segments you operate most often. It typically centers around making an adjustment, going back to the rig and checking results (oops, wrong way!), returning to the antenna for another adjustment, and so on. But wait! There is a super-easy alternative, and it works for home, portable, and mobile antennas alike. The new **MFJ-247 SWR Analyzer** with digital-frequency read-out shown in *Figure 5-7* is a complete self-contained and stand-alone unit that measures SWR and precise resonant frequency on any 160-10-meter antenna. You can take the unit right to the feedpoint of your dipole or beam, or right to the base of your vertical antenna, connect a short jumper cable to the MFJ-247's top-mounted SO-239 connector, dial your desired frequency or band-range, and read SWR directly

on its meter. You can also vary the frequency range while reading the SWR meter to determine 1.5:1 bandwidth or find the exact near-1:1 operating range. No more running between the antenna and shack for tuning: You can handle everything at one time and without transmitting even one-watt of power. I use one of these analyzers often, and it is a real time (and nerve) saver.

I also like the MFJ Analyzer for home-assembling my own mobile whips. In this case, I estimate their approximate operating range and then connect the analyzer to determine where they are resonant and make final adjustments to my desired operating range. As an example, I trunk-mounted a two-foot rod fitted with a standard Hustler 20-meter resonator on which I substituted a 41-inch whip for the usual short Stinger. The resultant antenna operates 30 meters with 3-5 dB gain over a standard Hustler fitted with a regular 30-meter resonator. This is because my design placed the loading coil above the auto's roof line and more than tripled the actual radiating top section. Now here are the interesting points: I quick-assembled the antenna from parts salvaged off other mobile antennas, mounted it on a rental car and tuned it on-frequency within only seven minutes. I then traveled to the beach with my 30-meter QRP transceiver on a short vacation. I made a number of great DX contacts with the mobile antenna, and even "beat out" several of the high power boys in the process. When returning home, I received a couple of letters inquiring what type of rig and antenna I was using for such a good mobile signal. Incredible! Want to quick-assemble your own "super skywire?" An SWR Analyzer like the MFJ-247 sure makes it a snap!

Another item every QRPer needs in his or her paraphenalia is a good low power watt meter. But homebrewing and calibrating such an item is quite challenging. One

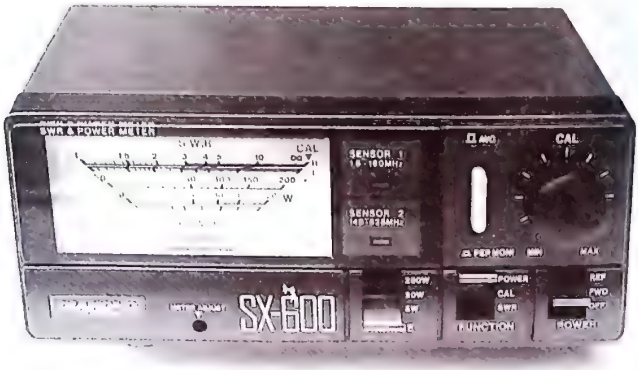


Figure 5-8—A good SWR and wattmeter is very important to QRP work, and one of the more impressive units I have found is the Diamond SX-600. This gem will read power down to 100 mW with high accuracy

of the best solutions I have found is the **Diamond SX** unit like that portrayed in *Figure 5-8*. This particular model reads SWR and power in three ranges: 200 watts full scale, 20 watts, and 5 watts. The five watt range is expanded below one watt and directly calibrated right down to 100mw. By looking "in between" marks, you can even measure power down to 25mw. This is not a high precision laboratory instrument, but I find it quite accurate and good for general QRP use. Diamond meters are presently imported by RF Parts Company, 132-16 Grand Avenue, San Marcos, CA 9269.

If you have ever need a small antenna tuner for portable QRP operation, and want to homebrew rather than purchase said item, here is your answer. The mini antenna tuner shown in *Figure 5-9* fits snugly in a small metal box, and it can be used with random-length longwires, dipoles, verticals, Windoms, and beams. Construction cost is low, and parts are readily available. This is a simple yet effective project you can be proud to say "I built it myself." Go for it!

Referring to *Figure 5-9*, capacitors C1 and C2 are regular open-air 365 pF variables. If you cannot find these standard AM radio-types, small 250 pF variables may be substituted directly. The coil is home wound on a small pill bottle with No. 16 or 18 bare or enamel wire. I personally prefer bare wire, as insulation does not need to be removed for tap connections. Punch two holes at each end of the pill bottle and pass wire ends through holes twice to secure them. Wind approximately 25 turns of wire on the pill bottle, then tap the coil at 1, 2, 4, 6, 8, and 15 turns. I used a pill bottle approximately two inches long and 1-3/4 inches in diameter, but this size and the number of turns on the coil is not critical. The tuning range of the variable capacitors provides significant compensation of switched inductances between turns, so you can use almost any size pill bottle and any coil with between 18 and 30 turns for the coil. Tap positions are, likewise, quite lenient. Since only low power RF levels will be used with this tuner, nearly any type of rotary switch can be used for S1. Check hamfest fleamarkets for suitable switches at good prices.

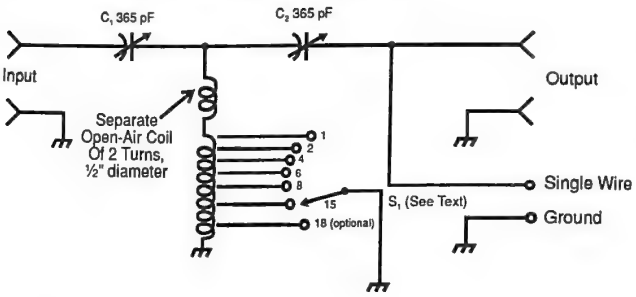


Figure 5-9—Schematic diagram of a small and easy-to-assemble antenna tuner for portable QRP work.

Assuming you install this tuner in a metal box, be sure both sides of the tuning capacitors (in addition to their shafts) are insulated from the cabinet. This can easily be accomplished by mounting the capacitors and the coil directly onto a half-inch sheet of surplus plastic which is then glued or bolted to the bottom of the metal cabinet. Insulated shaft couplings or plastic rods "crazy glued" to the capacitors will isolate them from the metal cabinet. Avoid rubber grommets for shaft-to-cabinet insulation, as they may arc over with higher RF levels. The plastic pill bottle can be glued directly to the plastic bottom sheet for stability. Coax connectors to mate with your equipment can be added on the back, and an insulated binding post can also be included for single wire antenna connections. Remember to securely solder all connections, and few problems should be encountered. Front panel layout is a matter of personal preference. I built my own tuner with a capacitor on each side and the pill bottle/coil in the center rear. This gave room to mount the rotary switch in the center. By raising the capacitors on small plastic bearings, all three shafts emerge from the front panel symmetrically. I then painted the cabinet with automotive "dupla color" paint to match my transceiver, added similar type knobs, and the unit looks like a mating accessory. Use your ingenuity, and you will probably come out with a finished product that looks even better.

Using the tuner is straightforward and should present few problems. While listening to signals on the receiver, switch coil taps to obtain maximum signal strength, then peak the two capacitors. This setting will be *approximate* and close to the point of lowest SWR. Next, apply transmit power and check the SWR. The coil will probably be set to an acceptable tap, so adjust the variable capacitor closest to the transmitter for lowest SWR and then fine-tune with the antenna-side variable capacitor. It's that easy! When using the tuner with a single wire, remember to include an effective ground system or counterpoise. A cold water pipe connection serves quite well for temporary use, however a few additional ground radials are encouraged. The wires can simply be laid on top of the ground rather than buried. If there are some large metal objects laying on the ground nearby, scrape a clean connection point and add them into your ground system. Every extra bit helps, and radiation of a QRP signal by any and all means available is the overall objective!

Figure 5-10—The Naval Electronics speaker has a built-in audio amplifier and is perfect for checking homebrew projects. It also adds room-filling volume to small transceivers that usually drive only earphones.

Clever Speaker and Earphone Ideas

Portable QRP operations typically involve using very small pieces of equipment, and regular size earphones can be larger than the rig! As a result, we often consider using one of the

small personal "in the ear" phones that can be carried in a shirt pocket. This idea is quite meritorious, but avoid "one dollar special" or "bargain basement" earphones that lack low frequency response. This is particularly true if you are using a direct conversion transceiver without RIT, because tuning and/or listening to a low pitched note assures you are "zero beat" with the other station. A perfect solution is the purchase of an inexpensive and optional set of "in the ear" 'phones from name manufacturers like Kenwood, Yaesu, and Icom. Alternately, I have found the personal-type stereo earphones available from regular consumer electronic dealers and even Radio Shack stores nationwide to be great for Amateur use. You simply need to rewire their plug for monaural rather than stereo use. The wide frequency response of these earphones is great. If you prefer only one earphone, incidentally, you can also separate the wires before the plug, add a separate plug for each earphone, and emerge with two for one! Check out these small shirt pocket-size earphones. They're neat.

A small paging trumpet, similar to the type added on many CB sets some years ago, makes a good selectivity-tuned speaker for CW and SSB operation. The natural resonance of this speaker acts like an audio filter in minimizing adjacent channel interference. In fact, you will notice an approximate 3 or 4 dB peak around 800 Hz when using a paging trumpet. If your transceiver has enough audio output, you can even point the trumpet out of the radio room for remote monitoring DXpeditions, pileups, etc. Small paging trumpets are usually available at Radio Shacks and other electronic dealers nationwide.

If you occasionally experiment with homebrew transceiver and receiver circuits, the **Naval Electronics** speaker shown in *Figure 5-10* is worthy of consideration. This unit has a built-in 3-inch speaker plus an approximate 15 dB audio amplifier that is perfect for boosting earphone levels to room-filling volume. When I plug it into the QRP transceivers described in Chapter 4, for example, they become "big rigs" with enough audio to be heard throughout my house! I also found the speaker great for test-trying various passive/diode and active/MOSFET receiver front end and mixer circuits. In fact, adding a simple diode mixer with inputs from the antenna and transmitter's oscillator, and output to the Naval Electronics speaker, produced an instant receiver, which coupled nicely with a *Oner* transmitter for a *flash-built* transceiver. In other words, applications for an amplified speaker are limited only by your imagination! The Naval Electronics' speaker is self contained, including three penlight batteries for power. For more information on this item, contact Naval Electronics, Inc., 5417 Jetview Circle, Tampa, FL 33624.

Simple Tape Recorder Trick

Cassette tape recorders amply prove their worth many times over during a number of Amateur activities, yet they are often overlooked by new Amateurs. Tape recordings of large pileups, for example, can be reviewed at a later time for fast insight into operating tactics that work. Likewise, tapes of successful QRP contacts can be shared with others in an enthusiasm-generating manner. Finally, tape recordings containing calls and exchanges are great for fast logging during contesting, portable

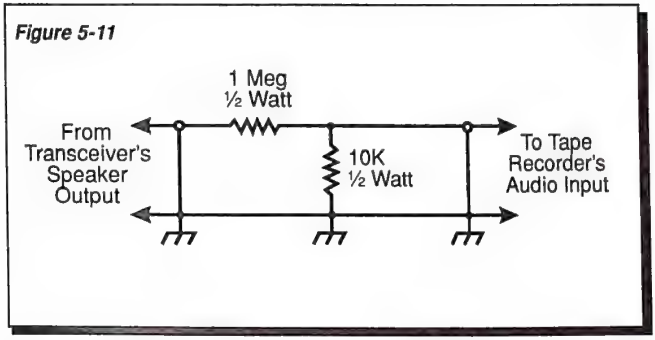


Figure 5-11—A simple circuit for connecting a tape recorder directly to your transceiver's earphone or speaker socket.

operating, or even mobiling. How can you interface a tape recorder with your receiver? Easy. Read on.

The simple circuit shown in *Figure 5-11* lets you connect the microphone of a tape recorder directly to your transceiver's earphone or speaker output. A 1-megohm,

Figure 5-12—John Rehak, N6HI, travels quite extensively during weekdays so he sets up his QRP station in motels at night. This arrangement brings the world right into his room and he has now worked over 84 countries while using less than 5 watts and a simple end-fed 30-foot wire antenna.

half-watt resistor is used to match impedances and mate the record level with the normal volume level of a transceiver. In other words, you set your tape recorder for its normal recording level and adjust your transceiver's volume for its usual level. You can then record off-the-air without *overloading* the tape recorder, and in most cases, recorders with only one volume control do not require resetting for playback. Insert the plug into the earphone or speaker socket only far enough for tape recording, but not far enough to bypass/disconnect the rig's speaker. This way, you can hear signals normally while recording off-the-air. After taping some of your special QRP QSOs, end-label the cassette for easy future reference. After you have a number of cassettes taped, you can store them in a popular carry-box available from various discount stores for future access. That's right: A QRP library of super QSOs!

This chapter presented a variety of station accessory ideas to enhance your QRP life and make Amateur Radio more fun. Use our suggestions in a "mix and match" manner as desired, and expand on them as you prefer. Experimenting and dreaming up your own special ideas and accessories makes QRPing great. Enjoy, enjoy!

Chapter 6

QRP-Attractive Antennas

Ask any QRPer their opinion of the most important item for successful low power operations and the answer is always **a good antenna system.** The significance of that statement really stands tall when you consider QRPers typically use less power than many Amateurs lose, with 100 watt setups connected to compromise or makeshift radiators. This does not mean you necessarily need a super-elaborate antenna (although that advantage definitely should not be overlooked!), but rather striving for the best antenna possible under your particular circumstances (and then enjoying the results). High-gain beam antennas are ideal for upper bands like 20 through 10 meters, but please don't short-sell wire antennas, especially if you have limited funds or pursue portable operations. Wire antennas are easily home-assembled and installed, they are low in cost, light weight, and easy to move. Some wire antenna designs are real "performers," *Even a basic dipole does a very creditable job when thoughtfully assembled and erected.* Additionally, there is a unique sense of pride and self satisfaction in *homebrewing* a good signal radiator made of wire.

The Difference Between "Makeshift" and Good Antennas

We often hear of Amateurs achieving great success with simple antennas while others report difficulty even communicating by way of seemingly elaborate skywires. What comprises that favorable difference? Sometimes it is luck and operator expertise. But usually it centers around planning and installing the antenna as a complete system that mates with its particular location. Consider, for example, the typical Amateur's setup, running a 100-watt-transceiver and using a vertical antenna. Assume this setup is located within the confines of a regular city lot (complete with trees and poor ground conductivity. This 100-watt signal will be degraded 3-6 dB by absorptions in nearby foliage while poor ground conductivity will not present a vital "mirror image" of the vertical radiator (another 3-6 dB loss). The resultant *effective radiated power* of this setup will thus be between 12.5 and 25 watts (almost QRP from a "big rig!").

Next, compare a QRP setup running five-watts output to a single band and well-tuned dipole, mounted at treetop level. In this case, the effective radiated power will be approximately four watts. The QRP signal will only be 4-7.5 dB weaker than the "big station." Now look at your receiver's S-meter and consider each 3 dB or doubling/halving a power level equals one S-unit. If distant stations received the "big rig's signal" at S8, your QRP signal would be S5 to S6. Take a break right now, and tune in and compare some S5 and S8 signals on your transceiver. Can you actually hear a difference? Do you have to look at the S-meter to determine which signal is actually weaker? Interesting, eh? The elaborate AGC system in modern transceivers does a terrific job of equalizing signal levels. The purpose of our previous example was not to downgrade verticals. In fact, they work very well when mounted in the clear, when they have a good horizon-to horizon view in most directions, and when they're complemented with a good ground radial system. I'm simply pointing out the extra advantages to using your location favorably and letting the antenna work to your advantage rather than being a handicap. If you're atop a mountain with a clear view and a good ground system, a vertical is fine. If you are in a valley and surrounded by trees, use them to raise your antenna and radiate a signal over the hills rather than into them. Fine points not to be overlooked include using only new, top-grade and low-loss coax cable. Avoid any splices. Firmly solder all antenna/coax/connector points. Trim antenna ends for the lowest possible SWR. When you can walk out your door, look up at your antenna and feel a real sense of pride (like it is a really impressive skywire for such a small rig), you're on the right on track for obtaining top QRP success.

Helpful Tips For Home-Assembled Antennas

The following information will prove most beneficial to newcomers, although it may seem somewhat like "old hat" to more experienced Amateurs. But, even if the facts are in the back of your mind, they are always worthy of stressing for good QRP results. When planning your first antenna, strive to select a foolproof horizontal type like a dipole, inverted vee, or single band Delta Loop. These antennas are easy to assemble and erect and there is little chance of failure. They do not require a tuner, and are a good reference for comparing future antennas. Most multiband doublets and G5RV-type antennas should be accepted as what they are: A compromise (particularly on the WARC bands). Vertical antennas are always appealing because they seem to require minimum mounting space and can be installed right at ground level. However, a vertical needs a good ground system and an unobstructed area to radiate a good signal. A vertical mounted within a few feet of a house, amidst trees, or supported by a single ground stake is choked and most of its energy is absorbed rather than radiated. Horizontal-type antennas usually sidestep these maladies. As a basic rule, horizontal antennas should be mounted at least 20 to 25 feet above ground. Installing them over 70 feet above ground becomes quite difficult. Strive for a happy medium. Avoid erecting the antenna directly over your station to minimize RF fee dBack. When routing coax cable into the house, exercise care to avoid sharp bends or pinches. Remove strain from the coax cable by propping it on available ledges, and whenever possible, lift it off the acidic ground and out of direct sunlight for longest cable life. If you end up with extra coax cable from your antenna in the shack, cut it off rather than coiling it up in a corner. Remember excessively long ca-

ble lengths absorb valuable power. Many people feel that standing waves of 2:1 or less are acceptable, if their transceiver does not overheat. Personally, I have found that any antenna works five times better than identical counterparts (dipole-to-dipole, for example) when end-pruned and coax length-trimmed for an exact 1:1 SWR. Some Amateurs may find humor in my striving for perfection, and that's fine. It's only my opinion, of course, and there are numerous opinions. I will just keep on working DX like crazy while they laugh and call. And call. And call...

Antenna System Aging—Have you ever noticed how a newly-installed antenna seems to work like gangbusters, then slowly drops off with age? Close investigation of this phenomena reveals some interesting facts. A few months after installation, both the antenna and the operator seem to settle in to an acceptable norm, in an unrealized manner. The antenna is attacked by weather and deteriorates with time. A strand of wire here or there cracks and breaks, a balun's case cracks and allows water seepage, and connections corrode or loosen in the weather. The SWR may rise ever so slightly, but it occurs so slowly we seldom realize it. Meanwhile, the coax cable is attacked by harsh chemicals and strong ultraviolet rays. Its inner dielectric bakes like it's in a microwave oven, and lumped impedance points are produced. Finally, the wire breaks and we put up a new antenna only to realize a new world has opened!

Can this dilemma be avoided? You bet! Begin by selecting only *top-grade wire*, coax cable, a high quality balun, and good connectors. Here are some additional notes and tips to keep in mind on home-assembled antennas. After soldering connections and/or installing plug-in connectors, be sure to weatherproof those outdoor points with a good grade of silicone. I have found Coax Seal sold by Amateur Radio dealers nationwide tops for ensuring that connection points and cable openings are not damaged by weather. Remove excess cable strain on center connections or baluns whenever possible. Plastic cable clamps affixed to your coax and secured with the antenna center insulator work fine here. Strive to support the coax cable so as to avoid wind flexing (use window ledges, wood chocks, flowerpots, etc.). The use of teflon-insulated PL-259 connectors is also encouraged. They deteriorate very little with age. All coax cables are not produced equally! Plastic or rubber-jacketed cable is more susceptible to chemicals and sun damage than polyvinyl chloride-jacketed cables (which exhibit the longest life). This lifespan, incidentally, is approximately 10 years from the time the cable is produced. That 10 year figure includes the time the cable is stored in a dealer's warehouse. I mention this because you can estimate a cable's life when purchased new, and then estimate the cable's remaining life and replace it accordingly. Yes, I know some Amateurs brag about using the same unmaintained antenna and coax for 20 years, and I love beating them out in the pileups! Enough said? And how do the previous facts relate to antenna wire? The popular stranded copper antenna wire that looks great at installation day and turns black a few weeks thereafter is an all-time favorite. To the best of my knowledge, there is no factual indication the "blackening effect" hampers radiation. I have noticed after one or two years, however, that strands of the wire become brittle and break (yuck!). Steel-core copper wire commonly known as Copperweld is quite popular for antennas, it is extremely strong and does not break (you can even pull

two trees together with an antenna between them!). ***Be careful when using this wire!*** It has a high tensile strength and will recoil like a spring when you unroll it. This can result in some nasty cuts. Personally, I prefer basic-style stranded and insulated wire for antennas. The size is a matter of personal preference. No. 18 or 20 is quite easy to work with but may break during high winds, whereas No. 12 or 14 is stronger but slightly more difficult to handle. Select wire according to your own preference. Remember to check every single aspect of your antenna system—it is in fact a system—once or twice a year for weather damage.

Helpful Notes On Antenna Installation

I have found the easiest way to install wire antennas involves combining modern technology with personal creativity. In other words, using a slingshot or weighted tennis ball tied to a light nylon rope, to lasso a highly positioned limb, rather than climbing a tree. If you have not tried this approach, practice in an open countryside away from power lines and homes before looking like a moonstruck baseball pitcher in your backyard. After an hour's practice, you will probably be able to zip a line right over a selected tree limb with only a few attempts.

I have found the new style slingshots, called "wristrockets" great for erecting wire antennas. These items are available at sporting goods stores. They are fitted with surgical tubing rather than rubber bands, are quite powerful, and can propel a large bolt or weight over 100 feet in the air with good accuracy. Alternately, a weight inserted in a regular tennis ball makes a superb "throwing object." If you would like to go first class in this best-of-all techniques, order a **Quick Launch Kit** from Antennas West, 2996 Cherokee Lane, Provo, UT 84604 or telephone (801) 373-8425. This inexpensive kit is terrific. It consists of two weighted tennis balls (in case you lose one), two long lengths of lightweight yellow nylon cord (for easy throwing and spotting), and two large rolls of strong black nylon cord (for pulling up and securing the antenna). These items are packed in a smooth-surfaced pail for easy storing, carrying, and launching right from the bucket (which eliminates cord tangles in ground cover). Whether you use the tennis ball concept (preferred) or wristrocket approach (be careful), the installation procedure is similar. Begin with a couple of practice shots, then connect one end of the lightweight nylon cord to your weight/tennis ball. Be certain there is enough nylon cord to extend from your position to well above and beyond the selected support or limb and back to the ground. Ready? Aim and fire! If you do not reach a desired branch, consider your odds for success before continuing longer. Once you are successful or accept a less-than-optimum limb, tie the light nylon cord to the heavier nylon rope you will use for securing the antenna. Connect the opposite end of that rope to an end or corner insulator on your antenna, raise it into approximate position and retrieve your lightweight throwing line. Then move to the antenna's other end or support area and duplicate the previously discussed process. Finished? Great! When pulling your antenna into final position, remember to allow plenty of leeway for tree limbs to move in both normal breezes and heavy wind gusts. You may also prefer to install light weights like bricks or paint buckets filled halfway with sand on rope ends so they will automatically take up slack during high winds. Okay, you say: that's enough discussion of antenna basics, now let's get to the skywires! The following pages describe some tried and proven

gems you will find delightful. Start with the largest one appropriate for your particular location, continue expanding during future times, and good luck to you in QRP DXing!

The Classic Dipole

Surely the most popular style of HF antenna is a *basic dipole*. This skywire is easy to assemble, low in cost, and a relatively good performer. In fact, numerous Amateurs (including your author) contacted their first 100 countries while using a simple dipole and low power transmitter. The dipole consists of a half wavelength of wire cut in its middle and RF-fed by two-conductor cable (see *Figure 6-1*). The usual feedpoint impedance of a dipole is around 50 ohms, thus coax cable like RG-8/U or (even better) RG-8/U-marine grade is used for transmission line. The dipole may be fed directly from coax, although a center balun is desirable for maximum performance. A balun minimizes feedline radiation and ensures a good antenna radiation pattern. One of the most impressive baluns I have found for QRP use is the small **PB** series available from Palomar Engineers, Box 455, Escondido, CA 92025. These "PB" baluns are quite small and handle up to 300 watts. They do an excellent job of ensuring proper RF distribution to dipoles and other centerfed antennas.

A half-wave dipole's overall length for a particular band and frequency can be calculated using the formula 468 divided by F in MHz = total length in feet. The length of each dipole "side" can likewise be determined by halving the previous number or using the formula 234 divided by F in MHz = length of each side in feet. As an example of formula use, let's use the 40 meter frequency of 7.1 MHz. The dipole's overall length will be 468 divided by 7.100 = 65.91 feet, or each side will be 234 divided by 7.100 = 32.95 feet. But wait! Before cutting your wire, add three inches to each dipole side for wrapping around insulators and later pruning for lowest SWR. It

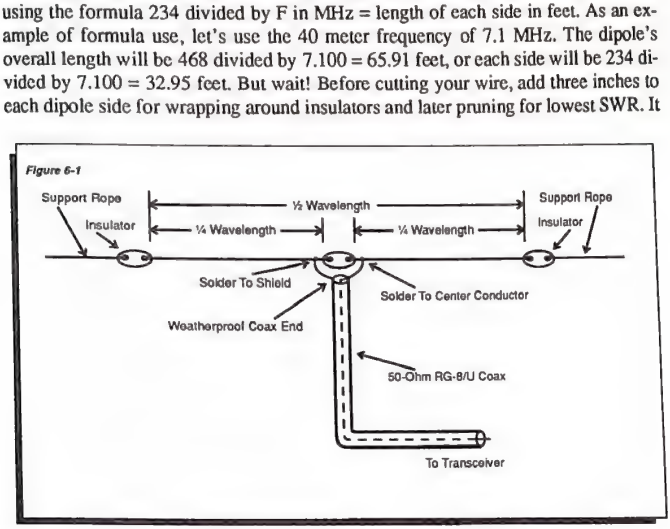


Figure 6-1—Assembly of the classic dipole antenna. This all-time favorite radiator is easy to construct, low in cost and perfect for portable QRP.

is much easier to cut wire off than to splice new wire on. When assembling your dipole, remember to solder all balun and/or coax terminals, and weatherproof them for long use. Pay close attention to coax openings or splices as moisture can seep in during the first rain. It will then be drawn along the cable's length by capillary action, set up corrosion, and rapidly render the cable useless. Do not take chances: Weatherproof any and all exposed cable openings with silicone or *Coax Seal*. One additional note: Strive to use a non-conductive item to support or hang the antenna. Nylon cord or rope is much better than spare antenna wire which can distort the radiation pattern.

When installing a dipole, bear in mind the maximum radiation is broadside with minimum radiation from the ends. Select the proper support trees, and you can thus radiate a good broadside signal into Europe and Australia. For best results, the dipole should be erected at least one quarter wavelength above ground, and in the most open area possible. This height is not difficult to achieve on the 30 meter and higher bands, but you will probably have to accept a compromise on lower bands. Do not fret, however, just install those dipoles as high as feasible and enjoy the results.

An interesting variation of the dipole involves angling each side to produce an inverted vee, such as the one shown in *Figure 6-2*. The angled elements will affect resonant frequency slightly, so calculate overall length using the formula 476 divided by F in MHz = overall length in feet. Likewise, each side's (one quarter wavelength) can be calculated using the formula 238 divided by F in MHz = length. As an example, 238 divided by 10.110 = 23.54 feet for each side of a 30 meter inverted vee. Get the idea? How long should the feedline/coax cable be for a dipole or inverted vee? Long enough to reach from the antenna to the rig! Seriously, however,

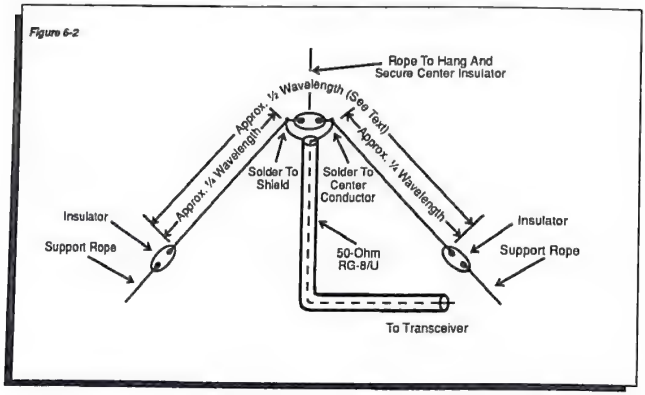


Figure 6-2—Outline of the Inverted Vee antenna. Only one tall center support is required for this popular radiator.

any transmission line length between approximately one-half wavelength and two wavelengths should work fine. The only points you necessarily need to keep in mind are that an exceptionally short transmission line means the antenna is probably not high enough, and that over two wavelengths of transmission line usually introduces noticable cable loss. Finally, an exact one-quarter wavelength transmission line usually inverts impedances. That is, a low impedance at one end (like 50 ohms) will appear to be a high impedance (2000 to 2500 ohms) at the opposite end. This fact explains why many Amateurs "prune" a transmission line (after trimming their antenna to resonance at a desired frequency). They are simply juggling feedpoint impedance so their 50 ohm-output transceiver "sees" an optimum match. Is that a good procedure? I think so, and my transceivers run quite cool as a result. But each person has his or her own opinion.

The Full Wave Delta Loop

This antenna is almost as easy to make and install as a dipole, but on-the-air performance is noticeably better. That's because a full wavelength of wire is used in the **Delta Loop**. It is arranged in an inverted triangle shape, and its combination of horizontal and vertical polarization is terrific for both in-country and DX communications. In addition, the Delta Loop performs well when mounted at relatively low height. I work the world with a Delta Loop and a QRP transceiver on 30 meters almost daily. Try one: You'll love it! The layout of the Delta Loop is shown in *Figure 6-3*. Each leg of the Delta Loop is approximately 1/3 wavelength. Each side can be supported by ropes to tree limbs at the top, and the lower feedpoint can be held in position by its attached coax cable. The antenna's overall wire length is calculated using the formula 936 divided by F in MHz = total wire length. As an example, 936 divided by 14.0 = 66.85 feet. Remember to add two or three inches to that figure for wrapping around the center/feedpoint insulator and frequency-pruning. Since the feedpoint impedance of a Delta Loop is slightly above 50 ohms, an impedance matching device is used. This consists of approximately one quarter wavelength of 75 ohm/RG-59/U cable. The cable's velocity factor must be taken into consideration when cutting this matching stub. In the case of RG-59/U, the velocity factor is 0.66. As an example of calculation, one quarter wavelength at 14.0 MHz is 234 divided by 14.0 = 16.71 (feet) X 0.66 (velocity factor) = 11.3 feet (total length of matching stub). Similarly, a matching stub for 7.100MHz will be 234 divided by 7.100 = 32.95 X .66 = 21.75 feet. Solder a PL-259 connector at the end of this matching section, plug it into a 83-1J double female adapter, then connect your usual RG-8/U or RG-8/U marine grade coax cable from that point to your indoor transceiver.

The easiest way I have found to assemble a Delta Loop involves initially measuring and cutting the wire outdoors, then laying out the antenna on the ground in its final shape before erecting it. This will give you a good idea of tree limbs to select for supports. Maximum radiation is broadside to the Delta Loop, with minimum radiation off its ends, so select your supporting tree limbs accordingly. Another hint: By simply threading the loop's wire through one hole in two insulators (one for each side), it will assume a Delta shape almost automatically when raised into position.

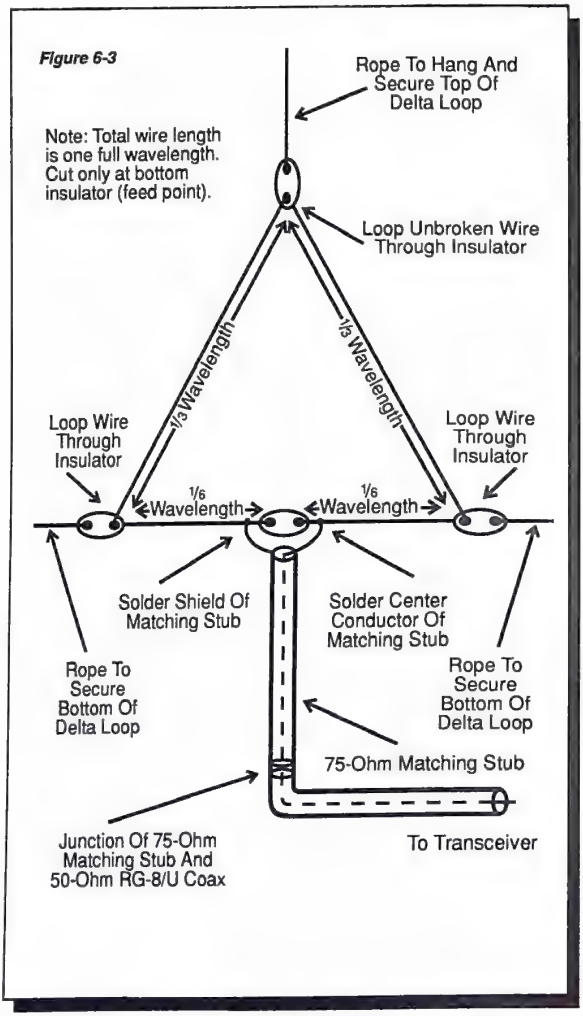


Figure 6-3—The full-wave Delta Loop is a simple wire antenna that will give your QRP signal a real boost!

If you really want to go first class, consider adding a reflector element behind your Delta Loop to make it a two element beam pointing in a desired direction. In this case, the reflector's length should be *5-percent longer* than the full wavelength driven element. Spacing between the two elements is determined by the formula: 120 divided by F in MHz. Example: 120 divided by 7.100 = 16.9 feet. Since the reflector is a *parasitic element*, electrical connection is not necessary. Just hang it in place, and use a continuous Delta Loop-shaped wire, with no center insulator required. This antenna does a terrific job, even when the feedpoint at the bottom is only 6 or 8 feet above ground.

The Slanted X Beam

Our next antenna, shown in *Figure 6-4*, is unique in several ways. It produces good signal gain in a selected direction while its sloped elements achieve a low angle of radiation for terrific DXing. This two element beam requires only a single center support. Spacing between the two inverted vee elements varies continuously along their length, however this shortcoming is offset by "veeing" the driven element's wires toward a favored direction. You change beam directions by manually shifting feedpoint clips and jumpers between wire sets. Alternately, a customized switching arrangement can be devised for "remote rotating" from your shack. I will leave the exact choice and details of that switching arrangement to your ingenuity. Several of these wire beams have been assembled during past times, and they always produced outstanding results. The cost and installation time are miniscule, and this antenna can turn your QRP signal into a real tiger.

Assembly of the **Slanted X Beam** begins by cutting two inverted vees for your desired band or frequency. Each "leg," or element, is a quarter wavelength at the de-

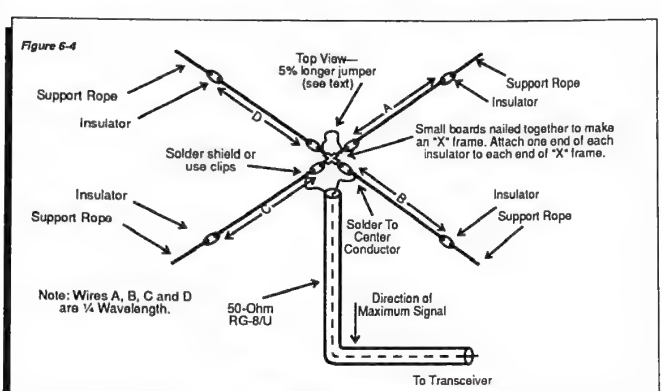


Figure 6-4—The Slanted-X Beam uses two sets of wires. One functions as the driven element and the other set is the reflector. It is power for pennies!

sired operating frequency. This length is determined by the formula: 238 divided by F in MHz = length in feet. As an example, 238 divided by 10.100 = 23.54 feet for each of the four wires. After measuring and cutting, make a center support by nailing a couple of small boards or tomato stakes together to produce an "X" frame to which each of the four wires can be affixed. Use four insulators for securing the end of each wire to the X frame. The insulators should be within two inches of each other to allow connection of jumper wires and coax or balun terminals. For temporary setups, clip leads connected to a center 50-ohm balun. Since the other two wires will form a reflector, this element's overall length should be 5-percent longer than the driven element. This jumper length is calculated as follows: 476 (overall length of driven element) divided by 10.110 (our 30 meter frequency example) = 47.08 (feet) X .05 (5 percent longer length) = 2.35 feet (length of jumper to install between legs acting as reflector). This jumper can be made of the same antenna wire as each of the four elements, and fitted with clips for temporary use. Signal rotation is accomplished by moving element feedpoints to select one pair of wires as the driven element and the other pair as the reflector. As previously mentioned, alligator clips can be used for temporary or portable operation while a more weatherproofed connection or arrangement is preferred for permanent use. Another tip: If you presently have a tower or tall mast supporting a beam for upper bands, simply adding egg insulators to its four guy wires (which you cut for a lower band before adding the insulators) will give you a second beam for 80, 40, or 30 meters. Many Amateurs have dreamed of owning their own low band beam but have been discouraged by the vast amount of real estate required. This array, however, can be installed in minimum space and costs only pennies. Now, who says a high performance beam for low bands is difficult to achieve!

Creative-minded QRPers can devise some interesting variations of my Slanted X Beam for portable use or for fitting into tight spaces. As an example, each of the

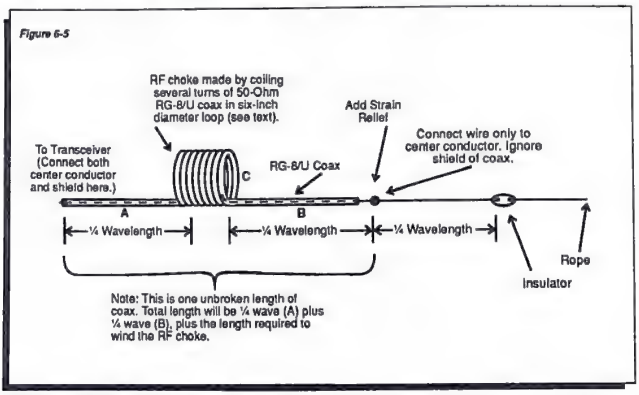


Figure 6-5—Introducing the End-Fed Dipole. This roll-up skywire is real handy for use in condos and apartments.

four angled or sloping wires can be bent back toward the center support in their approximate middle. Wire below each bend can be positioned at an angle or horizontally, according to available space. In this case, the complete antenna will resemble the frame of an opened umbrella. Now, step out in your own yard and visualize all the places a wire X Beam could be installed. This is a great antenna! Give it a try. You will like the results.

An End-Fed Dipole For Condos

I occasionally travel to the Gulf Coast for mini vacationing plus hamming, and always find small condos more economical to rent than large beach houses (4 bedrooms and 3 baths for two people?). Indoor antennas are hopeless in such metal frame and concrete structures, but each unit has a balcony or sundeck overlooking the beach and adjacent sands. Assuming one selects a condo above the first or second floor, quick-erecting an antenna simply involves tossing an end-fed antenna with securing string off the far end of the balcony. You can walk out from the condo and secure the antenna in place by tying the far end string to a small stub driven in the sand. By judiciously juggling condo selection according to bands of operation and antenna positioning, the resultant skywire can be oriented for good clear-area radiation and minimum signal toward the condo. Assuming the use of a dipole with end feed (yes, I know, most dipoles are fed in the middle but read on!), one end points toward your room and building, minimizing RF fee dBack, TVI, etc. When you leave, simply untie the antenna's far end, untape the balcony end, roll up the antenna while standing on the balcony, and pack it in your knapsack for the next time. One final tip: Try to select a condo with an open area in front of your balcony. This is especially important if you plan to operate the lower (and longer antenna) bands like 40 and 80 meters.

A sketch of my end-fed dipole is shown in *Figure 6-5*. Simply explained, a one-fourth wave wire attached to the coax cable's inside conductor forms one-half of the dipole while the coax outer shield comprises the dipole's other half. An RF choke made by winding a few turns of the coax establishes *where the dipole ends and its feedline begins*. The coax cable from that point to the transceiver PL-259 plug is one-quarterwave long for the operating frequency. Do not calculate velocity factor into that length. Therein lies the secret for end-feeding. A dipole nominally exhibits an impedance of 50 ohms at its center feedpoint and a high impedance of about 2500 ohms at either end. A one-fourth wavelength of transmission line acts like an impedance inverting transformer, so it matches the antenna's high impedance to 50 ohms. Does this really work? You bet! I have assembled several of these antennas for various bands; they always get out great and have a low SWR. Additionally, this roll-up antenna can be installed vertically, horizontally, or sloped to fit various circumstances.

Assembly of the end-fed dipole begins by measuring a quarter wavelength of wire for your desired band of operation. Use the standard 234 divided by F in MHz = length of wire formula for this antenna, just like described in our previous classic dipole. Example: 234 divided by 10.1 MHz (30 meters) = 23.1 feet. Add two or three inches to the wire's length for securing a small end insulator or string, then cut it.

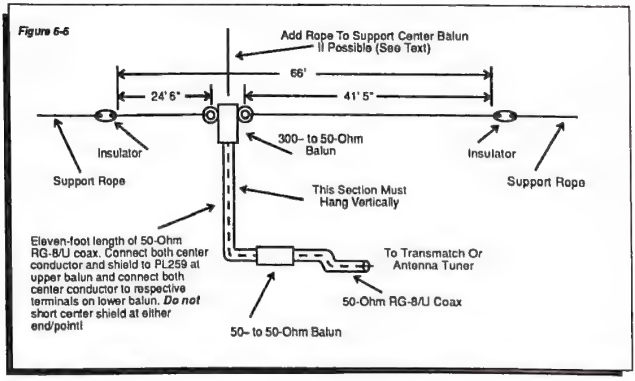


Figure 6-6—The Carolina Windom is a multband antenna that works like a champ, especially for QRP. Try it on your next vacation!

Next, lay your premeasured and cut wire beside the coax and use it to measure another 23.1 feet. Mark that point with a small piece of tape, then wind the coax into an RF choke approximately six inches in diameter. Wind three turns for 6, 10, or 12 meters. Wind four turns for 15 or 17 meters. Wind six turns for 20 meters. Wind eight turns for 30 meters, 10 turns for 40 meters, or 15 turns for 80/75 meters. Finished? Great! Now tape the coil in several places so it will retain shape. Next, move your premeasured and cut wire to the coil and measure another one-quarterwave length from the end of the coil (where coax to rig emerges). Install a PL-259 connector at that (rig's) end, and assembly is almost complete. The final step involves removing a half-inch of insulation from the premeasured and cut wire, then connecting and soldering it to only the coax cable's center conductor. Simply cut the shield off at this junction point. Tape and weatherproof this connection securely, then make a small strain-relief loop so the wire does not pull excessively on the coax's center conductor. I have found that high tropical heat is murder on just tape along as a stress relief. Add an extra clamp at this junction so that the far end wire does not pull excessively on the center conductor. Its stress will be directed to the full coax cable. If this roll-up antenna's SWR is higher than desired after installation, you can fine tune/prune it as follows. Move the RF choke slightly in either direction by unwinding a turn on one end while winding one turn on the other end, then retape everything in position and check to ensure you are rolling the right way. Once accustomed to this antenna, you will really like it. The little "critter" is inexpensive, goes together quick, and radiates a very good signal. In fact, one of my first contacts with this end-fed dipole was Albania—and I was only running five watts.

The Carolina Windom

Here is a new-style antenna that works 40 through 10 meters including the WARC bands, does not use traps, and runs circles around multiband doublets or G5RVs. I

Figure 6-7—Danny Gingell, K3TKS, checks out a new QRP transceiver demonstrated by the combined USA and British QRP clubs at the 1992 Dayton Hamvention. Can you hear that rare DX, Danny?

am serious! This is the next best thing I have found to a triband beam. Performance on 20 meters and above is outstanding. The **Carolina Windom** is approximately equivalent to a good dipole on 40 meters, and only slightly worse than a good balun-fed dipole on 30 meters (its weakest band). There is a "hitch," however. You must use an antenna tuner with this skywire. I have found the automatic antenna tuner built in many deluxe-style HF transceivers works fine with the Carolina Windom, or any of the generic manual antenna tuners can be used.

A sketch of the Carolina Windom is shown in *Figure 6-6*. One side of the top section is 24 feet, six inches. The other section is 41 feet, 5 inches long. Allowing five inches for the center balun, overall length will be approximately 66 feet. A regular

300-ohm to 50-ohm balun is inserted at the feedpoint, and an 11-foot length of 50 ohm coax (RG-58/U or RG-8/U) is connected between that balun and a 50-ohm to 50-ohm balun. A second length of RG-58/U or RG-8/U then connects between the second balun and your indoor antenna tuner. The 11-foot section between the baluns is the antenna's main radiator, and should always be positioned vertically. The length of coax between the balun and your rig is not critical. Likewise, pruning of this skywire is not necessary: You simply adjust your antenna tuner for lowest SWR.

While assembly and installation of the Carolina Windom are straightforward and pose few problems. A few tried-and-proven tips warrant mention, however. First, use wire for the horizontal top section that is strong enough to support both the baluns and the coax between them. Also, remember to weather-protect all antenna connection points. Best results are obtained when the Carolina Windom is erected high and in the clear. If you have a choice of only one of these factors, go for *in the clear*, as it will allow maximum signal radiation. If you are looking for a high performance multiband antenna at low cost, try the Carolina Windom. It is an excellent performer for QRP.

This chapter's overview of easily assembled wire antennas is only the tip of the proverbial iceberg. Additional styles and designs are endless. I strived to select types that fit different requirements and situations (and kindle your interest in home-assembling antennas). I invite (indeed, encourage!) you to build and use one or more of them in the near future. You will like the results, and there is also a special pride in saying "*I made it myself.*" If you really get hooked on homebrewing antennas, check out the G-QRP Club's antenna han dBook. It is loaded with great ideas and designs. Now onward and upward in the world of QRP!

Another QRP flash! After writing this chapter, I took another on-the-air QRP break with good results. During a 15-minute period, I worked OK1AUN and IS0WS while running four watts on 30 meters. The next morning, I contacted 3B8FG on Mauritius Island and VK3WQ in Melbourne, Australia on 20 meters while running four watts. Now, please! Don't just sit and read about all this fun. Make a vow to yourself to join the action now!

Chapter 7

VHF And UHF QRP

QRP fun is not confined to the lower-frequency bands, nor is it limited to general or higher-class licensees. Indeed, Amateurs of all license classes can have a ball with QRP on the VHF and UHF bands. This most definitely includes our new Code-Free Technician class friends. The small size, portability and lower-power settings in modern VHF/UHF equipment sets the stage for some quite enjoyable and challenging Amateur Radio operations. QRP truly reflects the classic proverb of the *operator rather than the rig making the difference.* Combining QRP and VHF pursuits can result in some very unique systems, like a limited range simplex autopatch or around-home TV broadcasting of video tapes or live "ham-cam" views. In many cases, QRP is actually preferred to restrict coverage. Interesting? You bet!

The need for given power levels decrease on higher bands and frequencies. A redefinition of QRP levels is therefore logical for VHF and UHF. The typical power levels on 6 meters, for example, is 20 watts and QRP is usually *considered as 5 to 1 watt.* On 2 meters, usual power levels are between 5 and 45 watts with QRP *considered as 100 mW or less.* As this book is being written, at least one new 2-meter handheld has been announced with a low power selection of only 20 mW. That is real QRPp and results in long battery life for limited range communications! Moving to the high end of our spectrum, 10 mW is considered high power for 10 GHz. Good communications are possible on this microwave band when using only 1 mW. Really! But since activity on 10 GHz is extremely light, why use QRP? Two brief examples would include a personal "wireless" intruder alarm to detect motion within a limited area or a three-channel TV "mini broadcaster" with only single-home coverage. Think about these unusual applications and you will agree that range-limited QRP and VHF/UHF are a perfect match.

The use of battery powered 6-meter, 2-meter, and 70-cm equipment is perfect for weekend mountaintopping. Such *mini-expeditions* hold the promise of almost as much fun as a full-blown HF DXpedition. The concept of mountaintopping involves

simply gathering your equipment and portable antennas, and heading for a nearby hilltop when band conditions are booming or during contests. If your selected location is on the border of two or more states or in a rare-grid square, you may be pleasantly bombarded with a small pileup! In fact, you may add several new states and numerous grid squares to your own contesting and award-chasing credit. Once you delve into low-power portable activities, you will agree this is Amateur Radio fun at its best! That's enough peak-previewing VHF/UHF QRP: Now let's discuss more specific details on a band-by-band basis.

6 Meters And QRP

Recent peaks in sunspot cycle 22 often raised the MUF (Maximum Usable Frequency) beyond 50 MHz. This produced some exciting QRP opportunities for all Amateurs holding a Technician or higher class license. Amateurs throughout the world rallied to work foreign lands and DXpeditions on 6 meters. They proved that one or two watts connected to a good antenna could span the globe. As this book is being written, 6-meter openings are still terrific but beginning to dwindle in frequency of occurrence. We thus encourage you to get rolling on 6 as soon as possible.

Six meters can seem like a sleeper when activity is low, but it is a real blast to operate on when the band is open. The key note to spotting these openings is monitoring widely accepted gathering and calling frequencies, and jumping when DX starts rolling in. Modern FM and SSB transceivers with all-mode squelch are perfect for silent and continuous monitoring. The basic idea here involves setting your rig for reception on a popular calling frequency like 50.110 MHz for SSB DX, 50.200 MHz for in-country SSB activity, or 52.525 MHz for FM direct action. Additional details of the 6-meter bandplan, incidentally, are shown in *Figure 7-1*. Since numerous Amateurs constantly monitor calling frequencies like 50.110 and 50.200MHz, they are mainly used for making initial contacts. You then move up or down in frequency for actual QSOs. In other words, avoid carrying on long conversations on nationally and internationally-adopted calling frequencies. Best monitoring results are realized when your rig's squelch is set quite loosely, as weak carriers and signals will cause it to open and alert you to 6 meter activity. When 6 begins opening, SSB stations will start stacking up and down the band from 50.110 MHz while CW stations will

Frequency	Activity
50.00 - 50.1 MHz	Morse Code/CW
50.10 - 50.60 MHz	Voice/SSB
50.110 MHz	DX monitoring/calling frequency
50.20 MHz	National monitoring/calling frequency
50.40 MHz	AM/voice monitoring/calling frequency
52.00 - 54.00 MHz	FM voice
52.525 MHz	National simplex/direct frequency

Figure 7-1—Widely accepted bandplan for 6-meter activities. The 10-meter frequency of 28.885 MHz has also been adopted as an "intercom" channel for checking and reporting 6-meter openings.

begin operating between 50.050 and 50.099 MHz. A number of CW stations consistently run less than two-watts output, yet their success in achieving the prestigious ARRL *Worked All States* award within a few months time is factual proof of the outstanding capabilities of QRP on 6 meters. In fact, this band will spoil you on short notice. Here is one tip that has proved beneficial for 6 meter operations. *Use a gain-type vertical antenna for general band monitoring, then switch to a Yagi beam antenna to work stations in a particular direction.* Another tip: *Occasionally checking commercial television channel 2 for out of town stations or skip DX TV.* This is an ideal way to recognize 6 meter openings because TV channel 2 occupies the range of 54-60 MHz which is "next door" to 6 meters! When you see Mexico or the Dakotas coming through on channel 2, you can bet that 6 meters is alive with action. Additionally, check 6 meters during meteor showers and when a strong weather front between your area and distant states. These two phenomenon also create good 6 meter openings.

An impressive variety of commercially-manufactured equipment is presently available for 6 meters. It almost entices one to purchase a unit simply on good looks alone. Icom's popular IC-575, for example, is a complete 10-watt 6 meter station with built-in power supply in an exceptionally small and *go-anywhere cabinet.* This all-mode transceiver, shown in *Figure 7-2*, operates from 115 vac for home use or 13.8 vdc for mobiling. It has 99 memories for SSB, CW, and FM, dual VFOs, built-in speech compressor and RF receiving preamp, plus all-mode squelch and a variety of band scanning modes. For dedicated QRP work, there is also a front panel *RF PWR* control that continuously adjusts output from 10 watts right down to almost zero. This is one deluxe transceiver. Additional information on the IC-575 is available directly from Icom America, Inc., 2380-116th Avenue, N.E., Bellevue, WA 98004.

Figure 7-2—This neat Icom IC575A is a complete six meter station in one exceptionally small cabinet. Add microphone, key, antenna, and you are ready for action.

If you hold a Novice, Tech-Plus, or higher class license, several compact and deluxe-featured HF transceivers also include 6 meter coverage. The Icom IC-729 shown in *Figure 7-3*, for example, operates 160-10 meters with up to 100-watts output, and 6 meters with up to 10-watts output. This rig's front panel *RF PWR* control also continuously adjusts output down to almost zero on 6 meters and down to almost 5 watts on the HF bands. An internal switch will change the controls range for HF so maximum power output is 50 watts and minimum output is in the milliwatt range. Details on this simple *switch modification* are available by telephoning Icom's Customer Service Hotline at (206)454-7619. The IC-729 is really hot: It has a triple-conversion receiver with front-panel,selectable-RF preamp and attenuator, passband tuning that works great for minimizing QRM, built-in speech compressor for high SSB talk power, and 26 memories. Using this transceiver for both low-band and 6-meter QRPing is really going first class! Additional details on the IC-729 are available from Icom America, Inc. Additional models of 6-meter transceivers and HF transceivers with 6 meters are being introduced almost monthly. Inclusion of all units is impossible in this book's limited space. We are not overlooking anyone intentionally, but simply making you aware of what is available in equipment. I encourage you to check recent monthly Amateur Radio magazines like CQ, QST, 73, etc. for the *full story* reviews of new and existing transceivers. They are, to put it mildly, absolutely fantastic!

What kind of antenna should you use for 6 meters? A small four-element beam is terrific, but you can also have plenty of fun with a simple vertical antenna. Additionally, most of the wire antennas described in our previous chapter can be scaled for 6 meters using the formula and simply substituting 50.110 MHz. The only possible exception is the Carolina Windom. Home experimenters might even create their own miniature version of this unique skywire for 6 meters! As a helpful guide to

Figure 7-3—Several HF transceivers, like the Icom IC729 shown here, include 6-meter operation and they warrant closer investigation. This approach gives you both HF and VHF QRP in a single package.

showing you how to scale some of the previous antennas for 6 meters, let's highlight my end-fed roll-up dipole. This antenna is a clever choice because you can whip one together in only minutes and even hang it from a motel's room if you purchase a rig at a hamfest and want to get on the air immediately. First, a dipole's overall length is 468 divided by F (50.110 MHz) = 9.33 feet. Each side's length is half that figure or 4.66 feet. Multiply that number by 12 (inches per foot), and each dipole section is 56 inches. You thus measure 56 inches of wire, connect and solder, measure 56 inches down the coax, wind a three turn coil of 6 inches in diameter, include 56 inches beyond the coil for (impedance-inverting) transmission line, and add a PL-259 connector for your transceiver. Since we are dealing with a higher frequency, let's go one step further to ensure proper RF decoupling on the transmission line. This is accomplished by installing two snap-on MFJ-type toroids on the coil (any point on the coil is fine; where each end of the cable enters/leaves the coil is optimum). Your completed antenna can be mounted vertically, horizontally, or sloped to fit between available supports. It is a convenient pocket antenna for traveling. Now, look back at other antenna designs in *Chapter 6* and start visualizing your own 6-meter skywire.

When sunspot counts are high, 6 meters is a true QRP haven. It is the ideal starting point for VHF/QRP pursuits, and a couple of watts makes a good accounting of itself on this band. Try 6 meters soon: I am sure you will find it quite enjoyable.

Operating QRP On 2 Meters

This VHF band is a hotbed of Amateur Radio activity, and it supports a wide variety of low power communications. Indeed, numerous FM repeaters throughout the country (and around the world!) provide wide area coverage for handheld transceivers running only two watts. There is also a vast amount of direct activity on Simplex frequencies. Almost all 2-meter handheld transceivers include a low power or QRP selection the operator can use as desired to extend battery life. If you have not explored the capabilities and range of those low-power settings, you are set for quite a surprise. When combined with a gain-type antenna, milliwatt-communicating can be quite impressive. When operating from atop high points like Lookout Mountain, Tennessee, or Pike's Peak (mountaintopping at its best), you can work several states with better results than *big stations* at lower altitude locations.

SSB operation on 2 meters is another area of terrific fun. In addition to mountaintopping and grid square DXpeditioning, operating 2-meter SSB from a private airplane or hot air balloon really creates excitement. In the case of aeronautical mobile, one Amateur usually pilots while the other operates. Flying at an altitude of 8,000 or more feet and making contacts is like having an antenna thousands of feet in the air with a very low loss transmission line. The communications results are so incredible *one actually has to use QRP to avoid interfering with all areas at once!* Impromptu aerostat mobile from a hot-air balloon can often be combined with vacations where such 15-minute flights are available at low cost. Most balloon pilots are intrigued with the idea of accomplishing unusual feats like radio communication, and are willing to give it a try. Hot-air balloons remain stable for fairly long lengths of time, so the Amateur passenger is set for some good DXing. Are we piquing your interest and creative thinking? Great!

As mentioned earlier in this chapter, a QRP or range-limited simplex autopatch for near-home use can prove most attractive. The difference between a simple autopatch (various models of which are advertised in monthly Amateur Radio magazines) and a regular repeater autopatch is the simplex unit works on a single frequency and connects to only a regular VHF FM transceiver. A tone decoder built into the simplex autopatch is used for connecting/disconnecting to the telephone line, and a built-in timing circuit switches between transmit and receive so the remote Amateur operator (with handheld transceiver) can control talk/listen times. The advent of modular telephone jacks has opened many new avenues of simplex autopatch flexibility. A small and self contained unit consisting of a low-power 2-meter transceiver and simple autopatch, for example, can simply be plugged in and used almost anywhere—at home, on vacation, or even while visiting friends or relatives. The typical simplex autopatch is usually set up in a fixed manner with a range of up to 25 miles. This is nice for group use, but a more range-limited concept is desirable for personal use. Enter the QRP simplex autopatch: A unit running only a few milliwatts of power to a small rubber duckie-type of antenna. The range of this system is only two or three city blocks for personal use. Clever, eh?

The block diagram of a typical simplex autopatch system is shown in *Figure 7-4*. Incoming audio from the 2-meter transceiver's speaker socket is connected through the autopatch unit to the telephone line. Likewise the telephone audio, from the other party, is directed through the autopatch unit to the 2-meter transceiver's microphone socket. The push-to-talk line controls transmit/receive switching, and an on-frequency carrier signal from the 2-meter unit "tells" the simplex autopatch when it should remain in the receive mode. Many simplex autopatches also include a ring back or *incoming call* function. This feature allows both initiating telephone calls and answering incoming calls right from one's VHF handheld transceiver. Initially,

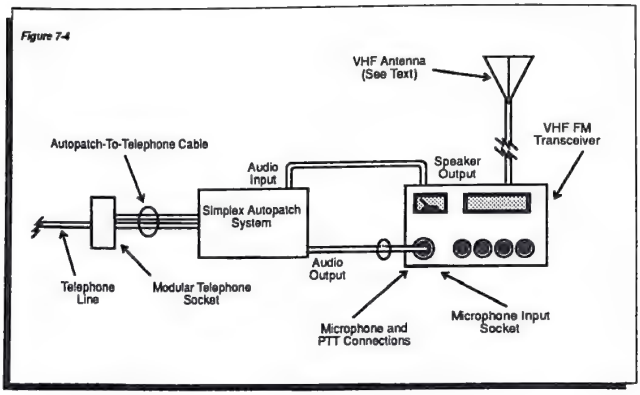


Figure 7-4—Block diagram of a simplex autopatch system. Range can be varied according to the power of the FM transceiver and the size of the antenna.

the simplex autopatch system sits quietly monitoring a selected 2-meter operating frequency. When an on-frequency signal with dual tones is received, the autopatch system responds with a dial tone. Consequent autopatching operations are then conducted in a usual manner, except this single-frequency system's transmitted signals are interrupted a few milliseconds each one or two seconds to "listen" for a signal from the remote/portable Amateur. If that signal is present, the patch locks into receive mode until the carrier is no longer present. The autopatch then returns to "switching mode" so the other party can talk. Termination of patch operations is achieved by the remote operator transmitting a dual tone code for slightly more than one second. The autopatch then disconnects from the telephone line, and relatches the 2-meter home/base transceiver in the receive mode. Additional "extras" for this system include a CW ID, extra timers and ring back capabilities that transmit electronic tones or transmit IDs when the telephone rings. QRP simplex autopatches are growing rapidly in popularity. If you have not yet checked out these clever systems, get cracking. They are really neat and they are only one more way you can have fun with QRP on 2 meters.

70-cm QRP? Sure!

This hot UHF band is another perfect candidate for specialized QRP activities. Mountaintopping operations on FM and SSB can be conducted, for example, in a manner similar to those described for 2 meters. Simplex-autopatch systems with limited range are also perfect on 70 cm, and restricting their range is even easier on this high band.

A glamorous array of 70-cm transceivers are advertised in monthly issues of Amateur magazines, and they are readily available from dealers nationwide. In the case of FM units, dualband 2-meter/70-cm transceivers are hot and popular units that give you the best of VHF and UHF in a single go anywhere rig. Alternately, 70-cm transceivers, with appearance and performance identical to their 2-meter counterparts, are an excellent choice. Several manufacturers also produce all-mode dual and multiband transceivers loaded with features for home use. These rigs are a blast of fun. In addition to regular terrestrial activities, they are also perfect for OSCAR satellite communications as we will discuss presently.

Another QRP activity associated with 70 cm and even 1.2 GHz is *Fast Scan TV* operations. These upper bands beg for ATV pioneering on a local level. A portable video system, for example, is great for visual coverage and assistance during local events and public services like parades, marathons, etc. Needless to say, they can prove invaluable during emergencies. A small TV transmitter that can be fitted inside a compact home video camera is available from P.C. Electronics of 2533 Paxson Lane, Arcadia, California 91007. This little milliwatt transmitter makes the camcorder a miniature ham transmitter. Coupling it with a similarly small size downconverter mounted inside a portable TV produces a unique "walkie lookie" which is ideal both for around home and for public service use. Another application for UHF TV involves connecting the output of your video cassette player to a miniature milliwatt ATV transmitter and then adding an Amateur UHF downconverter to home televisions for *wireless home broadcasting* of taped programs. The low cost of

QRP ATV transmitters and ATV downconverters makes your introduction to Amateur television quite inexpensive and most intriguing. Just try to visualize all the opportunities at your fingertips with QRP on VHF and UHF. It is an area of unlimited opportunities.

QRP Via OSCAR Satellites

A discussion on VHF/UHF QRP would not be complete without an overview of operations through our Amateur Radio satellites. These high flying OSCARs (Orbital Satellites Carrying Amateur Radio) are capable of relaying signals over a very large area, and they can be accessed with quite low RF power levels. Indeed, the low orbiting *Radio Sputnik (RS)* Russian satellites are a QRPer's dream. As an example, you can usually contact four or five Amateurs in various areas of the United States during a mere 15 minute period of a satellite pass while using only two-watts output. The only requirements are a transmitter for 2 meters, a receiver for 10 meters, and a knowledge of specific satellite orbits and operating schedules. This basic satellite information is presented in monthly Amateur magazines and announced each week on the OSCAR/AMSAT-NA nets that meet on 14.282 MHz at 1900 GMT. You do not need an Amateur license to simply listen in on this net, and the information you need is usually announced along with other bulletins. I have discovered that others will call in and ask the same questions I would ask, so transmitting is

Figure 7-5

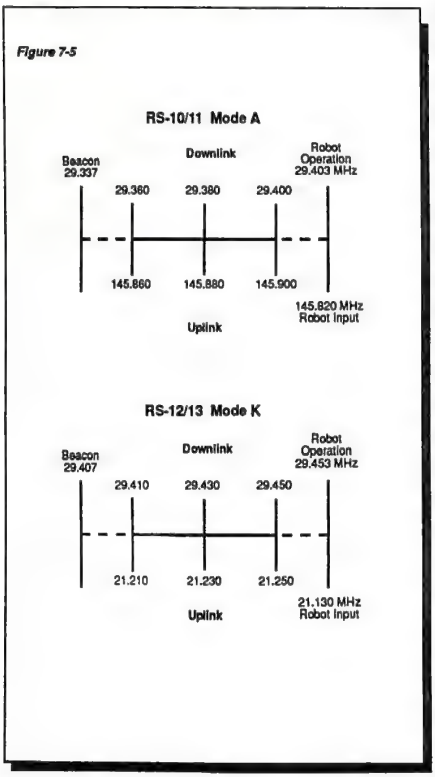


Figure 7-5—Operating QRP via OSCAR satellites is a blast, and "birds" like the Russian Radio Sputniks (RS) make it easy. Use this uplink/downlink frequency relation chart to plot your transmit and receive frequencies, and give it a try!

seldom necessary. Just keep listening! Computer programs are available for calculating orbital data, and predicting the appropriate passes for of each satellite, but again, listening to others talk about when they worked the satellites will give you a good reference of typical orbital/pass times. As an example, orbital times of the Russian RS satellites can be calculated by considering the fact that each pass progresses approximately one hour and 40 minutes, and each pass progresses approximately 30 degrees west of your location. Would you like more information on working the RS satellites amd calculating when they will be near your QTH?If, request a copy of the Nov/Dec issue of the *Amateur Radio Communicator* from **The National Amateur Radio Association**. This issue has an excellent article on calculating the orbits of RS satellites.

Uplink and downlink frequencies for the RS satellites are also easy to calculate. A specified 50 kHz "slice" of a 2-meter band is linearly translated to 10 meters on the RS satellites. An example of this frequency relationship is shown in *Figure 7-5*. Equipped with the pass time and frequency relation chart, you are set for some fun satellite QRP activity. Switch on your rig(s) approximately five minutes before a calculated pass occurs, and start listening for the satellite beacon transmitter. As this signals becomes readable, check your frequency relation chart and then start sending a few Vs on CW until you can spot your own downlinked signal. Do not waste time listening to your own signal (a pass will only last 15-17 minutes), but devote time to answering CQs from others. Your ability to operate full duplex (listen to your own downlink signal while transmitting your uplink signal) is vitally important for satellite operations. It lets you know how well you are getting into the satellite and when to rotate your beam antennas (if used). While a certain amount of QRP activity via OSCAR satellites is on CW, please don't neglect trying your luck with SSB and packet. **FM, incidentally, is absolutely taboo on the RS satellites.** It is very spectrum inefficient. One FM signal consumes more space than several SSB stations. The Russian RS satellites are extremely sensitive and perfect for relaying low-power signals. I have found only one or two watts to a vertical-whip antenna is fine for transmitting and a simple dipole placed low to the ground gives good satellite reception. Operating portable and even mobile satellite QRP is not a passing fancy. Rather, it is a lot of fun. An increasing number of Amateurs are enjoying it each day. Additional information on OSCAR satellites is available from AMSAT-NA, P.O. Box 44, Washington, DC 20044. Include an SASE with your letter request for information.

QRP On 10 GHz

Since most Amateur Radio activity on this high band frontier is in the 10-to 15-mW class, it may be initially considered QRP-oriented. A number of unique communications challenges are open to devoted low power pioneers. Many distance-versus-power records have yet to be recorded for this part of the radio spectrum. A popular means of measuring power on 10 GHz involves ERP, or effective radiated power, rather than direct transmitter output levels. Parabolic dish antennas are popular for increasing ERP levels at 10 GHz, but the QRP enthusiast is lucky as they can use smaller antennas. The little corner reflector or *horn* antenna built in or supplied with 10 GHz transceivers are ideal, and they really make these units almost pocket size.

One of the most popular and readily available transceive units for 10 GHz is the **Gunnplexer** available from Microwave Associates Company in Massachusetts. This unit is a complete 10 GHz front end which is used in conjunction with a low band receiver/IF strip. The Gunnplexer produces approximately 10 mW output with full power supply voltage. Its continuously-transmitted signal is also used as a local oscillator for its built-in mixer. During operation, two stations using Gunnplexers select frequency offsets by the amount of their IF/receiver. Incoming signals then heterodyne with a small portion of the transmitter's signal in the wave guide/mixer cavity of the Gunnplexer, and the resultant difference signal is output to the receiver/IF strip. A pair of 10 GHz Gunnplexers are relatively easy to set up and use, and they provide some very interesting microwaving experiences. Additional information on Gunnplexers is available from Microwave Associates, South Avenue, Burlington, MA 01803 or from Advanced Receiver Research, Box 1242, Burlington, CT 06013.

When used at high altitude locations, the range of very low ERP 10 GHz units can be quite impressive. More than one Amateur has communicated with others in several states from high vantage points in their state. Flat beach land is another good "proving ground" for 10 GHz communications. In fact, a couple of Amateurs in Florida recently established communications over a 75 mile path while using only two-foot reflectors and 5 mW Gunnplexers.

We trust this chapter's views of VHF, UHF, and microwave QRP pioneering inspired your interest. Please understand that our views are a collection of ideas and concepts for you to delve into and pursue as desired, rather than being complete and ready to assemble projects like the homebrew items featured in *Chapter 4*. For a real blast, combine VHF/UHF QRP operating with your low band QRP pursuits. Here's wishing you the best of luck in both VHF/UHF and HF QRP DXing!

Chapter 8

Battery Power For QRP Rigs

One of the most attractive aspects of QRP is its flexibility to mate with a variety of power sources. Since both QRP gear and batteries for low power operation are small and lightweight, the combination is ideal for all types of outdoor portable activities. That's right, a way to have fun with Amateur Radio in the great outdoors!

But that's not the only reward of using battery power. It's really a true blessing during times of power outages and/or emergencies, or for simply quick-setting up a station during weekend vacations. Many QRP transceivers have sufficient internal room for inclusion of a home-constructed or custom-battery pack. This produces a self-contained HF transceiver similar to popular VHF handhelds. Add a simple wall charger, and the QRP rig is truly ready for action anytime and anywhere.

What type of batteries are "best" for such QRP use? That depends on how often you use the rig, typical length of operating times, and how you maintain the batteries during nonuse or standby. Regular nickel-cadmium batteries are the popular choice, but alkalines, gel cells, and lead acid batteries are also quite useful. We will overview these items, then you can make your own decision, based on personal needs and preference.

Considering the proven track record of nickel cadmium, alkaline, and even carbon-zinc batteries used in 2-to 5-watt VHF/UHF handhelds, their use with similar power HF QRP transceivers is quite logical. Non-rechargeable cells or a battery of cells in the alkaline and carbon-zinc category (including lantern batteries) are "use and discard" items. But their widespread availability during QRP operating times or emergencies is a definite asset. A typical example is the traveling Amateur using a VHF-handheld transceiver with its accessory "refillable" battery pack. The unit's regular nickel-cadmium pack may become discharged when traveling via airplanes, but alkaline cells can be purchased almost anywhere and snapped into the battery

pack for continued operation. Yes indeed, non-rechargeable battery packs like that examplified in *Figure 8-1* have their advantages!

Rechargeable (nickel cadmium) batteries are, under normal operating circumstances, the most logical and cost-effective means of powering a typical QRP setup. These packs can be discharged and recharged or cycled up to 1,000 times, resulting in an approximate four-to five-year life span of relatively inexpensive operation. Bear in mind that nickel cadmium cells are available in a number of sizes and current ratings. The popular *AA*, or penlight cells used in VHF handhelds have a 500 milliampere capacity, while larger *C* cells usually provide 1,000 milliampere capacity.

A battery pack comprised of approximately ten 1.25 volt penlight cells will prove suitable for transmitters or transceivers up to 2.5 watts output.The larger C cells are suggested for RF levels between 3 and 10 watts. Gel cells and lead-acid batteries are also quite attractive for QRP setups. They usually provide greater current for longer operating stints or higher power. Automotive-type lead-acid batteries, however, tend to give off potentially dangerous gases during charging. They are also susceptible to being knocked over and spilling sulfuric acid. If the latter item is fully enclosed, such problems are eliminated and the batteries are outstanding selections for both low and high power operations.

The previously mentioned nickel cadmium cells (or battery of cells) may be considered a form of electrical energy storage tank. This hypothetical tank may be filled (charged) to capacity and used slowly or rapidly as required. This concept is analogous to connecting a five gallon gas tank to a 4-cylinder or 8-cylinder automobile. Both vehicles will be fully powered, but one will run for significantly less time than the other. There are, however, two noticeable differences in nickel-cadmium battery

Figure 8-1—Refillable battery packs like used with VHF handhelds are ideal for QRP use and alkaline batteries can be purchased almost anywhere.

used in this analogy. Heavy over-current loading can cause heat build-up which can irreversibly short-circuit the cell. Also, slightly more energy must be replaced than initially drawn from the nickel-cadmium battery.

Assuming normal operations, rechargeable batteries can be used like an electrical storage tank. The only noticeable difference is their lack of a visual indicator or gauge showing the amount of energy used or remaining in the cells. This situation is actually not a problem. Early model Volkswagen automobiles, for example, did not include a fuel gauge in their instrumentation. The auto owner merely kept mental tabs on gallons and mileage to avoid running dry at inopportune times.

Such mental calculation concepts can also be related to nickel-cadmium battery use. As a working example, assume a QRP transceiver draws 200 milliamperes during receive and one ampere during transmit. Let's also assume use of a 12.5-volt, 1-ampere battery pack consisting of ten 1.25 volt rechargeable "C" cells (one ampere-hour rating each). The QRP transceiver will operate in the transmit mode approximately one hour on a fully charged battery or approximately five hours in receive mode before the battery is completed discharged (1 ampere times 1 hour = 1 ampere-hour; 200 milliamperes times 5 hours = 1 ampere-hour). A typical QRP operation consists of approximately 15 minutes total transmit time for each hour's use. Relating those facts to the previous example, we find 45 minutes (.75 hour times 200 milliamperes = 150 mA), and 15 minutes (.25 hour times 1 ampere = 250 milliamperes). Total used current is therefore 150 + 250, or 400 mA. Approximately 600 mA, or 1.5 hours use, remains in the batteries before total depletion/discharge.

Since "pushing" battery life to absolute limits does not allow a margin of safety, we would thus be safe allocating one hour rather than 1.5 hour use before recharging. Simple enough, eh?

The technique of monitoring battery current and use is, within normal variations, surprisingly accurate and dependable. The calculations need not be pinpoint accurate and can be "rounded off" as desired for easy use. The previous example of current availability and use can also be related to all types of batteries. They all have milliampere-hour ratings and can be considered storage tanks, which you can keep track with simple mental calculations. An Amateur following this concept need never again face a surprise situation of unexpected battery discharge. Additional information on battery pack design and charging will be presented later in this chapter.

Nickel-cadmium batteries and Self Designed Battery Packs

Nickel-cadmium batteries gained widespread acceptance in the Amateur Radio world by powering popular VHF handhelds, and they have truly proved to be cost-effective power systems. When properly used, nickel cadmiums are capable of at least 1,000 discharge and recharge cycles. Indeed, at least one present manufacturer's guaranteed lifespan of their rechargeable batteries are holding true to such claims. Amateurs seriously interested in battery power are well-advised to consider the numerous benefits of nickel cadmiums versus nonrechargeable batteries like al-

kalines, etc. One of the most appealing aspects of nickel cadmiums is that they do not give off dangerous gases while being charged. These cells use a dry electrolyte and can be placed internally or externally to associated equipment in a worry-free manner.

Nickel-cadmium batteries are particularly unique in Amateur Radio and QRP applications, as they exhibit an almost constant output until reaching their point of deep discharge. This aspect of acquiring useful power for the longest possible time is a decided advantage over several other types of batteries.

As previously mentioned, nickel-cadmium charge and discharge parameters can be analogized to an electrical storage tank. The main prerequisite simply involves avoiding severe discharges that may cause cell reversal and shorting, and remembering to fully discharge nickel cadmium packs every two or three months rather than always keeping them topped up. This occasional discharging keeps the cells from developing a memory. Unlike lead-acid batteries, nickel cadmiums tend to set an operating span around their usual charge/discharge points. If a particular NiCd pack is consistently discharged to approximately half of its milliampere-hour rating, and then fully recharged, it will eventually be usable only to that half-charge point. This "quick death" syndrome can be sidestepped by occasionally discharging the batteries all the way down and then "bringing them back up" to full charge. The habitual "memory" is thus eliminated, and full storage capability is restored.

A home constructed QRP rechargeable battery pack and mating charger can be assembled in a variety of ways to mate with specific requirements and needs. A 2-watt or lower-power backpacking transceiver, for example, would be best powered from a group of 1.25 volt *AA* (500 milliampere-hour) cells. A higher power transceiver will usually need *C* (1,000 milliampere-hour) cells. Exact cell count will depend on desired output voltage.

Most QRP rigs operate from a 12.5 vdc source, thus approximately 10 cells are used. Physical design and construction of a nickel-cadmium battery pack centers around the required voltage and current, and amount and shape of available space. If 500 mAh is sufficient and available space/internal area is in a "blocked form," the cells can be arranged accordingly with a piece of heavy art paper separating two layers. The entire homebrewed pack can be held together with electrical tape and fitted with a suitable plug/connector. Look at some commercially available battery packs and you will get some good ideas for assembling your own counterparts. You may elect, for example, to use some of the regular battery holders like available from Radio Shack stores or you may simply configure your own pack to fit available space (like an "L" configuration).

The next step in battery power system design and implementation involves planning and assembling a suitable charger. The exact design of this unit will be dictated by voltage and current desired. This is where knowing the milliampere rating and desired rate of charge is important. Nickel-cadmium cells can be regularly charged at

approximately one-tenth their mAh rating for approximately 12-14 hours. This usually requires applying 1.3 to 1.5 times the battery pack's total voltage from the charger to the pack to ensure the proper charging current.

Rapid charging of nickel-cadmium batteries is accomplished by applying approximately one-fifth the cells rated current for approximately five hours. While yet higher rates (which can reduce total charging time to one hour) may be used with most nicads, homebrewing such circuits involves monitoring temperature and voltage which may be difficult. We recommend maintaining rapid charge value to the previously mention 1/5 amount. Further, it has been proven that one hour charges do not last as long as five hour or 12-14 hour charges. Consequently, I personally do not advocate rapid charging on a day-to-day or week-to-week basis (although many people report using this technique exclusively with good results).

Some Amateurs prefer to keep nickel-cadmium batteries "topped up" and ready for use on a continuing basis via the use of a trickle charger. This technique involves applying 1/100 the batteries' mAh rating for an indefinite period of time as desired. A 500 mAh pack, for example, can be left on a trickle charge of 5 mA for a long number of hours or even several days for producing instant readiness. The inherent low current of trickle charge is usually insufficient for recharging completely depleted nickel cadmiums; It is basically used to maintain pre-established charges during long standby times.

A Universal Nickel-Cadmium Battery Charger

Although self designed rechargeable battery packs vary in appearance and current-delivering capabilities, a mating charger can be constructed at home quite easily. Using the previously discussed information, a unit capable of both rapid and normal (plus trickle) charging can be assembled from readily available parts today. The charging contacts or connectors, naturally, must be fabricated according to the battery pack it is used with. Many times, regular screws and nuts or phono plugs and jacks can be used for contacts to charge the batteries without removing them from their equipment. If this is possible, we suggest adding a separate switch or circuit-interrupting jack for electrically disconnecting the rig from the batteries during charge. This will avoid accidental application of excess voltage to the rig, and ensure full charging current is applied to the nickel-cadmium cells.

If you are homebrewing a QRP rig with built-in batteries, a second circuit opening jack is also suggested for bypassing the nickel-cadmium connections and applying external power. This feature is particularly appealing when you desire to charge the batteries and operate the transceiver simultaneously.

The schematic diagram of a universally-adaptable nickel cadmium charger is shown in *Figure 8-2*. The power transformer should be capable of delivering approximately two times its associated battery pack's voltage, and current almost equal to the battery pack's output. This high current stipulation avoids transformer overheating dur-

ing long charging periods. Such transformers are usually available from local area Radio Shack stores, electronic parts houses, hamfest fleamarkets, etc.

Any diode with a PIV. of three times the output voltage and with current handling ability at least twice the maximum output (during rapid charge) can be used for D1. Capacitor C1 can be any value between 100 and 1,000 mF, depending on junkbox availability.

The pilot lamp is used for current limiting during rapid charge. Its type can be selected through use of voltage-current charts available at most electronic supply stores. If a rapid charge current of 100 mA is desired, a 100 mA pilot lamp (of the approximate charging voltage) should be selected. Likewise, if a 200 mA charging rate is desired, a 200 mA lamp should be used. The lamp provides a visual indication while it restricts current flow to the nickel cadmium pack. The trickle charge resistor, R1, is selected experimentally according to nickel-cadmium pack ratings. The value shown is typical for a 12 volt, 500 mAh pack.

The zener diode on the output is optional, and may be included or excluded as desired. The zener's rating should be slightly (but not excessively) above charger output during operation and with the battery pack connected. I should point out if the nickel cadmium pack is not connected, output voltage can rise above the zener's regulation point and cause it to overheat. During operation, however, the zener should provide ample overvoltage protection to both the battery pack and charger.

Operation of the battery charger should begin by placing a jumper between the charger's negative lead and the battery's negative contact, then inserting a milliam-

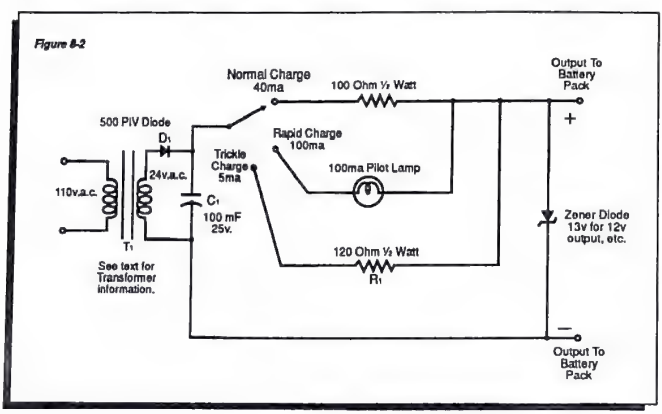


Figure 8-2—A universal nickel-cadmium battery charger. The text describes an easy method for adapting output voltage and current to a variety of battery packs.

pere meter in series with the positive connections (positive meter lead to charger; negative lead to positive terminal of battery pack). Switch the charger to "normal" then check to ensure 1/10 mAh current is being drawn. If charging current is too low, reduce the resistor's value slightly. If charging current is too high, increase resistance. Next, switch the charger to "rapid" and check its 1/5 mAh rating as previously described. Finally, quick-check the trickle charging current. Install connectors, mount the charger in an appropriate cabinet, and enjoy your new rechargeable battery system. Remember to occasionally discharge the cells completely for longest life and top performance.

A Universal Nickel Cadmium Checker

One of the most helpful accessories for a nickel-cadmium battery pack is an accurate charge-monitoring device. Although this can be accomplished with an external meter and a handful of clip leads, a small and easy to use pocket equivalent is much better for portable operations. The monitor I will describe was first used with my 2-meter handheld. A few years later, I realized its advantages for QRP rigs. Now it is an integral part of my QRP paraphenalia. I am sure you will also find this little gem useful.

The item's theory of operation is based on the fact nickel-cadmium batteries deliver almost full output voltage until reaching their point of discharge. At that time, output gives a slight warning decrease in voltage and then drops abruptly to a very low value. A graph of this discharge curve showing output voltage versus operating time is shown in *Figure 8-3*, and the monitoring circuit is shown in *Figure 8-4*.

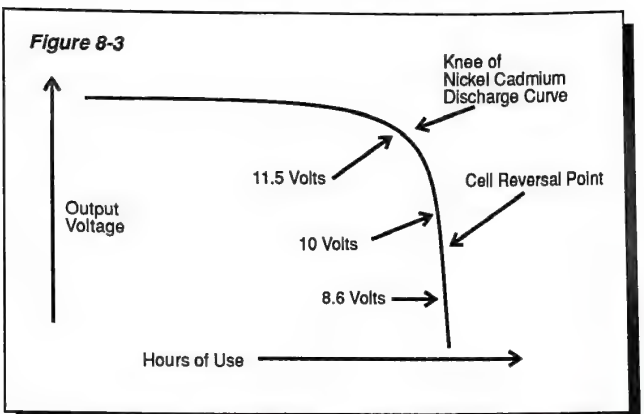


Figure 8-3—Discharge curve of a nickel cadmium batttery pack showing the output voltage versus operating time.

Referring to *Figure 8-3*, you will notice the pre-discharge battery voltage is constant near maximum, and then drops quickly when approaching depletion. The nickel-cadmiums' discharge knee is easily detected by a zener diode.

As shown in *Figure 8-4*, the monitoring circuit consists of a regular light-emitting diode (color and style chosen according to preference), a low wattage zener diode with a voltage rating between the battery pack's full charge and discharge level, and a 1/2 or 1/4 watt load resistor of approximately 270 ohms (assuming 12.0 volt battery pack). The zener diode conducts in its reverse direction until battery voltage drops below the zener point. The LED then extinguishes, indicating the battery-discharge knee, and warning the operator of an approaching discharge condition. A few minutes' use later, the batteries will become fully discharged.

Construction of my knee detector is straightforward and simple. The only consideration is use minimum lead lengths to avoid RF pickup by the monitor unit. The LED, resistor, and zener diode can be arranged in any series circuit-sequence desired. Your author built several of these battery monitoring units for various FM handhelds and QRP HF transceivers. Each was supported by three parts built around an extra plug that would mate with battery charging terminals. They work great. The monitor units are used only occasionally to check battery condition, rather than being left permanently connected.

The real key to this battery monitor is proper calibration. This is easily accomplished with the aid of a variable low-voltage power supply and volt/ohmmeter. First, measure the battery pack's voltage with the VOM as a point of "reference." Next, connect the meter across the power supply and set its voltage to equal that of

Figure 8-4

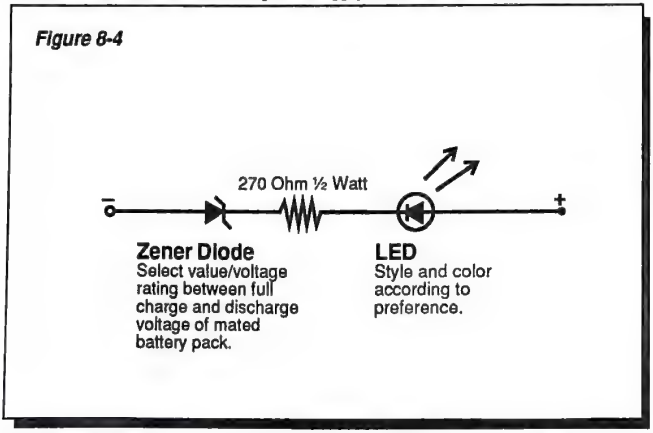


Figure 8-4—Battery charge monitoring circuit for nickel cadmium batteries. The zener diode rating should be between the full charge and discharge points of your particular battery pack.

the battery pack. This will simulate the full charge, half charge, knee and discharge voltages. With the battery monitor connected across the power supply, vary supply voltage over the batteries' discharge curve and note operation. The LED should remain illuminated until the knee of the battery pack is reached. The LED should then extinguish sharply within a .01 volt range. As an extra calibration step, the transceiver's output may also be checked using the variable voltage supply.

Do not apply excessive voltage!! The LED's brightness can be varied, and the indicated knee point "fudged" slightly in either voltage direction by varying the resistor value slightly. When the exact resistor value required for a specific battery pack is determined, the LED should light until battery voltage begins to drop. The LED should then extinguish. Using the battery monitor is the height of simplicity. Merely place the monitor on your battery pack's terminal and glance at the LED while you are transmitting.

Remember to recharge the batteries before they reach total discharge, and you will enjoy the full life of which the pack is capable. Additionally, this simple monitor will assure you of not being caught off guard with a depleted battery pack. Build one. You will love it!

Zapping Nickel-Cadmium Cells Back To Life

The technique of rejuvenating apparently dead or shorted nickel cadmium cells by "zapping" them with a high current for a short period of time may not be public knowledge, but it works! Seeing the process in action, however can be a little frightening. The first time I saw a friend doing this, he was placing poor defenseless *AA* cells across his automobile's 12-volt battery for a few seconds. There was a miniature fireworks display, but he emerged with rejuvenated cells!

When an aged nickel cadmium cell is deeply discharged, an internal short circuit often occurs and renders the cell useless. Occasionally, this short circuit can actually be detected with an Ohmmeter (assuming, naturally, absolutely no voltage appears at the cell's output terminals). If (and only if) this situation is noted, the otherwise worthless cell can be subjected to "zapping." Bear in mind this rejuvenation method is a "last resort" for hopeless cells. Do not attempt the technique otherwise.

Zapping is accomplished by applying 30-50 times normal charge current (and with the same positive-to-positive polarity) to the shorted nickel cadmium cell for no longer than five seconds. This high current "burns away" internal shorts, leaving the cell in its previously discharged (but unshorted!) state. The cell is then recharged at its normal rate for 12 to 15 hours. The lifespan of rejuvenated nickel cadmium cells depends on a number of factors and therefore is difficult to define, but an additional six months' use is a conservative estimate.

Naturally, the most logical concept involves purchasing new nickel cadmium cells and maintaining them in healthy condition from the start. Also remember, battery packs made up of many nickel cadmium cells usually have only one dead or shorted

cell making the whole pack look dead. Replace or zap that cell back to life, and you have a good working battery pack. Nickel cadmiums have proven their worth for many years, and they are a real asset for QRP operations.

Gel-Cell Batteries

Another popular battery pack with special appeal for QRP operations is the Gel Cell. These items are often available in high current and at desired voltages. They are fully sealed and can be transported without worry over electrolyte spillage or leakage. Additionally, gel cells are not prone to the memory syndrome of nickel-cadmium batteries. Indeed, gel cells may be considered the ideal solution for occasional QRP outdoor activities where fresh batteries are desired.

A typical 12 volt, 7 ampere-hour gel-cell battery enclosed in a nylon bag with carry strap is shown in *Figure 8-5*. This item was acquired from a hamfest dealer, and was originally intended to power my regular 100-watt transceiver at the reduced level of 50 watts output during power outages and emergencies. Needless to say, the battery pack works terrific for QRP operations. It will power a 2-5 watt transceiver for a full week of occasional use or through a solid weekend of heavy use without recharging. The shoulder strap and case are quite handy for setting up a station on the beach. Gel cell power systems like the ones shown are quite common at hamfests. Keep your eyes open, and snap one up the next time you see it.

Automotive-Type Lead-Acid Batteries

Lead-acid storage batteries like used in small automobiles and motorcycles are bulky and sometimes difficult to handle, but they are a relatively inexpensive high capacity storage device with some very good assets. Use of these batteries can be separated into two categories—providing power for very long periods of time with QRP equipment, and powering regular 100-watt output transceivers for home use during emergencies or portable activities.

Figure 8-5—High capacity gel-cell battery packs are ideal for extended portable QRP operations. They are available from numerous manufacturers advertised in Amateur magazines, and also sold at hamfests nationwide.

The typical lead-acid battery is capable of storing 150 to 185 amperes, or 12.5 volts times 170 amperes to deliver 2125 watt-hours of energy. This level may seem enormous for QRP setups, but one definitely need not worry about recharging during continuous weekend or week-long operations!

Storing lead-acid batteries requires a careful understanding of several important points. **Its electrolyte is sulfuric acid, thus**

spills or leakage can be quite dangerous. The acid can eat through carpet, linoleum, and the floor (!) within a short period of time. This acid also attacks clothing and flesh and must be handled with extreme care.

Placing lead-acid batteries on glass-type supports has proven beneficial. **While being charged, lead-acid batteries give off an explosive gas.** The amount of gas is directly proportional to the charging rate. Thus, sufficient ventilation must be provided for safety. This combination of gases and electrolyte leakage discourages placement of lead-acid batteries in the radio room proper, yet they should be protected from outdoor weather elements. Assuming a shed, garage, etc. is located close by, the battery might be stored there and connected to the rig via heavy leads. Just be sure ambient temperature is not excessive in these storage areas, and sufficient ventilation is provided for the battery.

Finally, a hydrometer for checking specific gravity and an accurate ammeter can be used for keeping a close watch on the battery's condition. Hydrometers are usually available from automotive supply stores.

Motorcycle-type lead-acid batteries are miniature equivalents of automotive batteries and often prove quite useful for QRP activity. These units are relatively small and readily available. They are easily transported, and their size permits assembly of custom enclosures to fit various needs. Motorcycle batteries suffer the same disadvantages as automobile batteries—namely, emission of explosive gas, and close attention to avoid acid spills or leakage.

Newer style *Freedom batteries*, or completely sealed lead-acid batteries are another good choice that definitely should not be overlooked. Another idea worth considering if you are a QRP DXpeditioner is powering your rig from an on-the-spot purchased lead-acid battery. As an example, let's say you travel to the Bahamas with only a rig and antenna. Upon arrival, you might strike a bargain with a taxi driver to visit a local automotive supplier where you purchase a replacement battery for his vehicle. In exchange, the taxi driver would fully charge the new battery (which will become his property after your DXpedition) then drop off you and your gear on a beach. Once a day, the taxi driver would recheck with you and/or exchange batteries with the one in his vehicle so you could continue operating nonstop. After your 1, 2, or 3 day blowout expedition, you leave the island and donate the battery to the taxi driver. Clever, eh?

The New Quantum "Ham Battery": Perfect For QRP!

This recently-introduced item is primarily designed to power modern handheld FM transceivers at full (5 watts) output power for extended periods, but it is a natural for QRP activities. The **Quantum Ham Battery**, shown in *Figure 8-6*, is a fully sealed 12 volt, 2.1 ampere-hour lead-acid battery. It has built-in charge monitoring circuitry and top-mounted LEDs, short circuit and overcharge protection. The battery is enclosed in a hefty leather case approximately 7 X 3 X 2 inches (H,W,D), and weighs approximately two pounds.

The Ham Battery is supplied with a heavy-duty wall charger, and has a belt clip for carrying. Dual output connections on the top let you connect one or two rigs simultaneously. The third socket accepts the charger. Three of the top-mounted LEDs indicate full charge, 2/3 charge, and 1/3 charge. This built-in metering circuit is a real asset for portable operations.

Unlike nickel-cadmium batteries, the charge in this lead-acid battery can be "topped up" anytime desired without worry about "memory syndrome." Since an overcharge protection circuit is included, you also need not worry about leaving the battery on charge too long. When you get ready for an outing, make sure the battery is fully charged, and you are all set! The main purpose of this battery is powering handheld transceivers. Thus its manufacturer sells various interface cables to connect between the Ham Battery and a handheld. They also have an HB cable that consists of a coiled cord with plug for the "Ham Battery" on one end and leads you can wire to a plug for your QRP equipment, on the other end.

I use this battery with several QRP transceivers and also use it for home experimenting (a nice and convenient 12 volt source). I have no reservations in recommending it heartily. This is really a neat item for portable use! For more information on the Ham Battery, contact Quantum Instruments, Inc., 1075 Stewart Avenue, Garden City, NY 11530.

As this chapter has pointed out, QRP and battery power are a perfect match. Both are easy to set up and quite flexible for portable activities of all types. In fact, the ability to take Amateur Radio into the great outdoors is one of the most enjoyable aspects of QRP. Try it during your next weekend camping expedition. I am sure you will find it a refreshing change of pace.

Figure 8-6—The new Quantum Ham Battery contains a fully sealed 12 volt, 2.1 ampere-hour lead acid battery, plus built-in charge monitoring circuitry and top-mounted LEDs indicating charge in battery.

Chapter 9

Natural Power Sources For QRP... And More

The capability of powering both QRP and higher power Amateur setups by natural energy sources is appealing from a dozen different aspects. It also opens unlimited opportunities of personal expression. Indeed, such freedom from regular power mains is most rewarding during times of emergencies, or for lowering utility costs when the system is large enough to power most home appliances. This chapter will look at both of those aspects and, although our accompanying figures depict big systems, they can be downsized with smaller batteries and regulators for QRP use. Bear in mind this is an "ideas" chapter to explain the basic concepts rather than a complete ready-to-follow guide for a specific system. In other words, think creatively and design your own natural energy system.

The most popular techniques for acquiring natural energy involve solar cells, wind power systems, and hydro generators. Solar systems usually employ a mosaic-arranged array of silicone photovoltaic cells. They convert sun energy into voltage and current that maintain the charge in a bank of high-current, deep-cycle storage batteries. Home constructed wind and/or water power systems usually employ replacement-type automobile generators or alternators, voltage regulators, and a bank of lead acid storage batteries. Gearing arrangements and/or belt drive systems usually provide improved efficiency of the overall system. Stored energy is usually drawn from the system's batteries, with consequent charging of the batteries accomplished by the generator/alternator. The benefits of such natural power sources are quite numerous and range from occasional or full independence from public utilities to a unique power system for QRP rigs. Additionally, after the units have been used for three or four years, they provide the equivalent of "free service" with miniscule additional expenditures.

The most attractive natural power system at the present time is solar energy. Large solar power systems prove their worth each day in an increasing number of homes and commercial facilities throughout the country. Additionally, the Federal government allows income tax deductions for solar power investments, thereby adding an extra level of appeal. Extensive solar energy systems, such as those capable of supplying full power to a home, are not in the low-cost category. They can be reduced substantially in size (and price!), however, to easily power a QRP setup. Cost of the latter system typically falls within the 50 to 300-dollar bracket. Any natural power system necessarily uses direct current rather than alternating current. If used for the home, this may require a slight "restructuring." Borrowing ideas from recreational vehicles and travel vans, we find 12 vdc refrigerators, water heaters, fans, and blowers for gas-type heaters. These units are usually smaller sized than conventional 115/230 vac equivalents. However they can be used advantageously in small dwellings or combined in various ways for large volume applications. Long term use of natural energy for powering regular 115/230 vac appliances usually is not cost-effective, due to required power conversion. A 12 vdc to 115 vac inverter typically exhibits only 50-percent efficiency. A 400 watt natural power system would be reduced in application to only 200 watts. Direct use of dc, however, permits full power availability in an effective manner.

Most areas of the United States receive sufficient daily sunlight to maintain solar power systems. Assuming such arrangements are planned around 12 vdc items and a sufficient number of storage batteries are utilized, the system is capable of many years operation with miniscule maintenance. The instigation and use of solar energy can be an exciting experience closely akin to those associated with many Amateur Radio installations. Assume, for example, we have elected to illuminate a room using three 36-watt fluorescent lights (chosen for their high efficiency). Each light draws 3 amperes at 12 volts (3 times 12 = 36 watts). Further, 3 (lights) times 36 (watts) times 2 (hours use per day) = 216 total watts per day. Bear in mind, this system must be capable of replacing slightly more energy than normally drawn from its storage batteries. Allowances must be made for inclement weather. A solar energy and storage battery setup capable of supplying approximately 250 watts would thus be logical for this particular system.

As an Amateur Radio-related example of using natural energy, let's consider a 70 cm repeater operating by solar energy. Let's also assume this repeater is used for approximately one hour transmit time and 23 hours of receive time per day. As a matter of calculation, we will also assume the use of a 12-volt unit that requires 2-amperes receive and approximately 37-amperes transmit. 23 (hours) times 2 (amperes) and 1 (hour) time 37 (amperes) = 83 total ampere-hours. This figure is "rounded" to 85, and multiplied times 1.2 to include system losses. The resultant 102 daily ampere-hour load is divided by a nominal daily peak sun hour time (5, for example) for a figure of 20.4. This is divided by 1.9 (peak output per solar panel) to indicate 10.7, or approximately 11 solar panels required. Let's consider the previously mentioned 102 daily ampere-hour load and 5 sun days which equal 510 ampere-hours available energy during inclement weather. 510 ampere-hours times 2 (50 percent battery drain during that time) = 1020 ampere-hours total energy re-

quirement. This can be fulfilled with six 12-volt, 185 ampere-hour lead-acid batteries. The previous calculations were presented to inform and encourage you rather than confuse you on the use of natural power systems. Our mathematics illustrate the approximate maximum technical level required to plan and set up such a system. As you can see, it is really not that difficult. Photovoltaic panels and full solar-energy systems are available from a wide variety of manufacturers, and often advertised in both Amateur and "do it yourself" home improvement magazines. You can purchase a large solar panel for charging gel-cell batteries to make a nice QRP setup.

A Closer Look At Solar Energy Systems

The general setup for a solar power system consists of one or more solar panels, a charge controller with regulator and metering unit, and a bank of high current, deep-cycle batteries. The exact number of solar panels and storage batteries will be determined by your desired ampere-hour rating. As a beginning point of discussion, let's say we purchase a solar panel capable of producing approximately 14 volts at 2 amperes during direct sunlight. The typical QRP transceiver draws an average current of one ampere during a period of one hour's operation. Assuming the use of that one ampere per hour transceiver along with the 14-volt, 2-ampere solar panel and a (fully charged) lead-acid battery capable of storing 100 amperes. The system could be used on an almost nonstop basis. Going a few steps further, let's assume the QRP transceiver is to be used in conjunction with this system approximately four hours a day. One (ampere) times 4 (hours) = 4 ampere-hours power required. The next day another four hours of sunlight would provide 4 (hours) time 2 (amperes), or 8 ampere-hours. Since this system employs a voltage regulator,

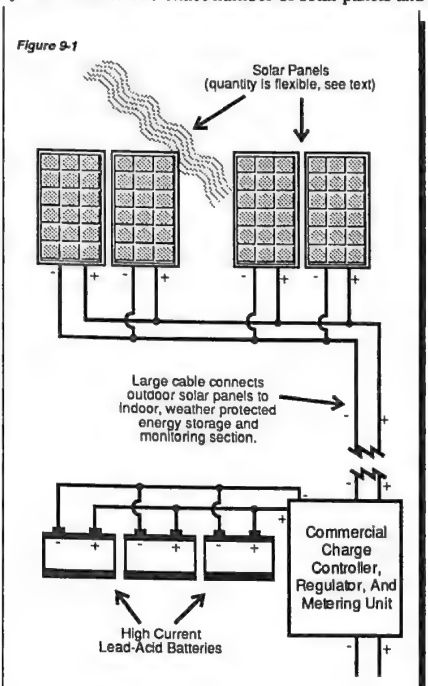


Figure 9-1—The basic layout of a solar power system. Any number of solar panels and batteries may be connected in parallel to achieve a desired level.

however, recharging is complete without damage or overcharge. Assume further, a small solar-power system consisting of a 4 ampere-hour (or larger) motorcycle battery and a small (50ma) solar panel is used with the QRP transceiver. An approximate two hours operation will draw 2 ampere-hours from the battery, leaving an approximate half charge. At least 40 hours of sunlight will be required for replacing that 2 amperes (.050 amperes times 40 hours = 2 amperes). Meanwhile, only 2 amperes remain in the battery until full recharging takes place. As you can logically surmise, size and capability of a particular solar power system is directly related to the amount of energy desired and the particular hours of operation planned. Bearing these thoughts in mind, let's now consider design of a solar power system for Amateur use.

The layout of a general solar power system is shown in *Figure 9-1*. One or more 14-volt, 2 ampere solar panels are utilized. Output from the panels is connected via a relatively large cable to the weather-protected charge controller/regulator and storage battery. This battery bank is similar to those described earlier in this chapter. One, two, or more 100 or 150 ampere-hour batteries are used in conjunction with the control and metering system. Essentially, that is it! You simply connect your 12 volt unit(s) to the output.

Solar power systems can be used effectively in most areas of the United States. The only criteria is an average amount of sunlight for daily operation and a sufficient storage capability to withstand cloudy days. QRP setups, with their associated miniscule power requirements can operate over extended conditions with such systems.

An Overview of Wind Power Systems

A few years ago, wind power systems began rising in popularity in the United States. These air-driven systems utilized turbine-type arrangements mounted atop variable direction masts or towers to charge a small bank of storage batteries. The complete arrangement proved more than sufficient for powering a 100-watt transceiver approximately 1.5 hours a day. Such wind-power systems were particularly attractive to Amateurs living near coastal areas or atop mountains. Since these areas experience almost continuous wind flow, harnessing that energy was quite logical. Popularity of wind generators has declined slightly, but their use for natural energy definitely should not be overlooked. Indeed it is an ideal backup for solar power setups that also thrive in coastal areas. Cloudy days are often windy days.

As a means of determining available energy force winds, an Amateur may make their own measurements with an anemometer or check with a local weather bureau. Bear in mind energy force rather than prevalent winds are necessary for turning wind turbines. If your area has sufficient winds, you can home-construct your own unit or purchase a wind-generator kit from suppliers listed in many home-improvement magazines. Individual items like feathered or variable pitch blades, can also be purchased from a number of suppliers nationwide. This eliminates the critical steps of designing aerodynamically efficient propellers. The ideal wind turbine should be capable of free movement in the horizontal plane. This is usually accomplished by a

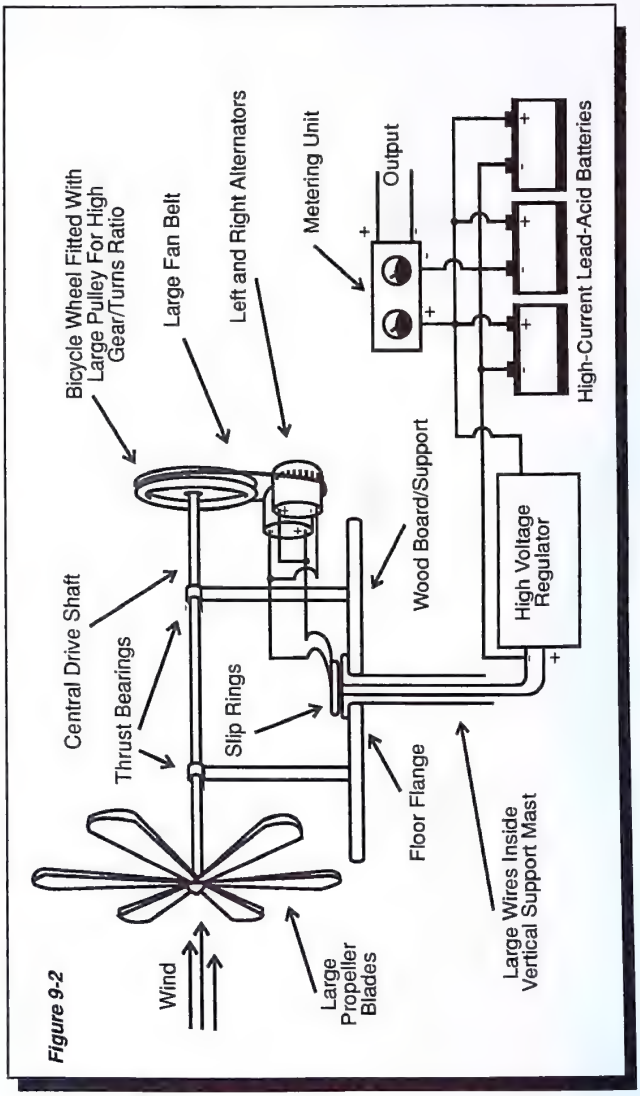

Bicycle Wheel Fitted With Large Pulley For High Gear/Turns Ratio
Large Fan Belt
Left and Right Alternators
Metering Unit
Output
Central Drive Shaft
Thrust Bearings
Slip Rings
Wood Board/Support
High Voltage Regulator
High-Current Lead-Acid Batteries
Wind
Large Propeller Blades
Floor Flange
Large Wires Inside Vertical Support Mast

Figure 9-2

rear fin on the turbine and use of slip ring connectors. Clever home constructors might also install a second fin or blade that swings up horizontally in winds or drops down vertically during low wind periods. This particular design would disconnect the alternator from the batteries during "still times" to avoid discharge. An efficient wind turbine should also be capable of withstanding high winds without blowing apart or falling over. We will leave the exact physical designs to your personal ingenuity. Finally, a voltage regulator system is used with the storage batteries to prevent overcharging or electrolyte boiling during times of high winds.

The basic layout of a wind-power system is shown in *Figure 9-2*. Home constructed or commercially obtained propeller blades are attached to a central drive shaft (a center spreader-mount for a quad beam might work fine here). A large pulley (such as a bicycle wheel) is attached to the opposite end of this shaft. A low friction shaft support and thrust bearing assembly is used on the drive shaft, while a small board and floor flange supports everything and allows horizontal movement. The generator/alternators can be reverse-mounted for rigidity, then a cover can be fabricated and installed over the complete turbine. A single 12-volt automobile alternator is sufficient for storage battery recharging, however two properly phased alternators give greater output. An alternator can be placed on each side of the turbine's center wood support/mount, resulting in equal weight distribution and smooth pulley balance. Large 2-conductor cable, connected through a slip ring assembly on the floor flange, then moves power to the ground section.

The ground-located section consists of a bank of 12-volt storage batteries, a voltage regulator, and an output voltage/current metering setup. The exact number of storage batteries (and their current ratings) will depend on individual system requirements. Most auto batteries are stamped with their ampere-hour rating. This figure can be followed provided the batteries are new. Otherwise, their ratings should be decreased 25 to 50 percent. Likewise, use of rebuilt batteries is questionable because their ampere-hour rating is less than expected, and they are prone to freeze or discharge if left outdoors.

The alternator(s)-metering setup and voltage regulator can be obtained from a local junkyard if desired. Assuming the electrical system is removed intact from an automobile, reconnecting it at home should prove quite simple. Chrysler Corporation electrical systems have proven to be outstanding and quite reliable. Additionally, separate panel mount meters (like Simpson, Triplett, etc.) may be used in lieu of automotive equivalents. Protective housing for the batteries—plus adequate ventilation!—and a hydrometer for checking specific gravity, should complete the list of bare essentials for this system. Remember to keep all power leads as short as possible; Direct current cannot be successfully transferred over long distances.

Since an Amateur QRP setup requires miniscule power, wind generator systems can usually be employed quite successfully. As an example, let's say you have a QRP transceiver that draws 700 milliamperes during receive and a maximum of 2 amperes during transmit. Assuming heavy use and extended transmitting time, we

might calculate one ampere for each hour's on-the-air operation. A single lead-acid battery exhibits 150 ampere-hours storage capability. This type of battery preferably should not be discharged over 50 percent so we can still realize 3 to 3.5 days of operation during low-wind times. A continuously-diminishing charge, however, will eventually gain ground on the QRPer and cause battery charge to drop below 50 percent. This condition should occur only during periods of extensive use, such as dire emergencies. Otherwise, wind generator systems should prove quite attractive for QRP work.

Water Power Systems

Although water power systems may be the least attractive natural energy source, their use for QRP or backup power for other systems can prove quite fruitful. This is particularly true during emergencies involving inclement weather, or when used in conjunction with other natural power sources. The QRP enthusiast (and others living near natural waterfalls) may thus learn more about this hydro system, but there are several hidden aspects that definitely cannot be overlooked. There are generally two water power categories: small drainage/overflow arrangements and larger reservoir/damming setups. The smaller arrangement may be adaptable to many Amateur applications, depending on the amount of energy desired and the amount of seasonal water flow. The majority of water power systems are necessarily limited to approximately 25-percent efficiency. This is because approximately 50-percent absorption of rainfall by the ground and approximately 50 percent of the remaining water could pass through a paddle wheel. The water force against this wheel should be approximately equal to one-half the wheel's diameter. A heavy shaft then transfers rotation to an associated alternator. Before discussing exact designs, let's consider some aspects relative to large water power systems.

The Amateur desiring to use water power will probably be situated near a natural waterfall or drainage, otherwise a similar situation must be created artificially. Assuming a medium-size lake or water reservoir with an "upstream" and "downstream" area is nearby. A suitable position for water damming and alternator installation should be considered first. In some cases it may be beneficial to purchase land adjacent to the reservoir for confidence in minimizing lawsuits from future overflows or floods. *Murphy's Law* somehow reigns supreme at the most unexpected times. There is also a possibility of problems with downstream tenants (those located beyond the dam you build), and peaceful coexistence in this area can become a touchy situation. Downstream aquatic life also relies on reservoir water supply, and may be severely threatened if you build a dam: A point which should not be taken lightly. Indeed, a rare species could become endangered from unknowledgeable damming. Investigation may reveal migratory fish and require a bypass or fish ladder. You will amost certainly require permits. In some cases, there are government prohibitations about water diversion. **Study the law and existing condictions carefully before delving heavily into water power systems.**

Sufficient safety emphasis cannot be placed on homebrew dams. Even a small dam may create a seven foot wall of water when broken. Dam arrangements should always include a flow-by gate, or bypass, for expending excess water and avoiding

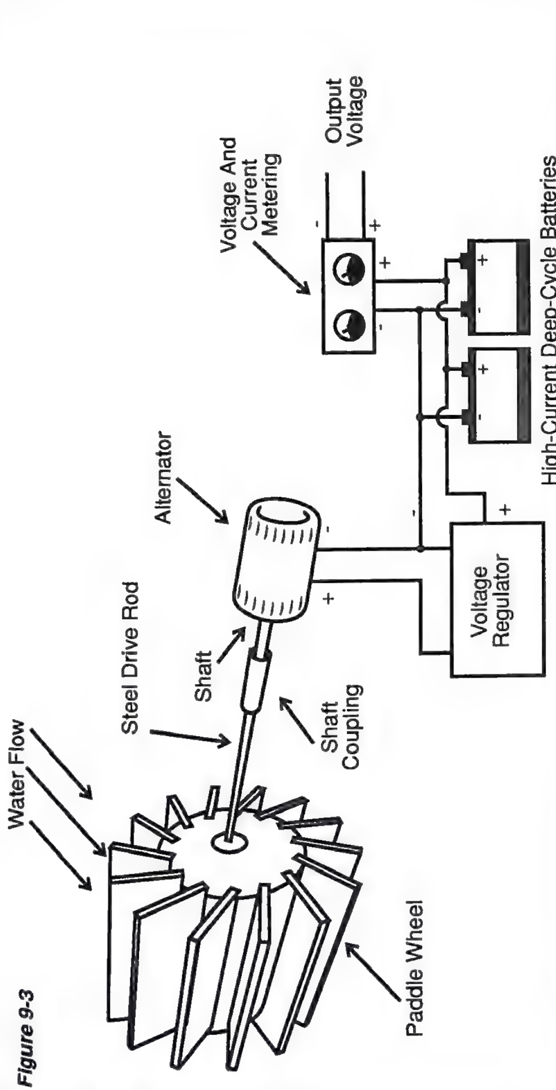


Figure 9-3—Outline of a water-power system. The waterfall energy turns paddle wheel which is connected to alternator by strong drive rod.

dam breaks. I am not trying to sound "heavy-duty" or "big-time," *I simply want to give you all the facts up front* and hopefully answer the questions on expanding small systems into large systems at the same time.

Additional information on water power systems is available at your local library's technology department. The low energy requirements of QRP make water power systems quite appealing. Such systems are usually employed on an eclectic basis, yet they can prove quite beneficial during emergencies or stormy weather. The prime consideration here is power availability when conventional services are out of operation. Additionally, the sheer novelty of harnessing water power adds to its appeal. Although each water power system will vary in design, a general outline of a basic water power system is shown in *Figure 9-3*. Paddle wheel size and design can follow a variety of personal creations, or ideas may be acquired from riverboats, local dams, etc. The paddle wheel's rotation (output torque) is connected to the alternator via a steel drive rod. Since the generator is usually mounted close to the paddle wheel, this drive rod's length is quite short. A suitable shaft coupling is then used between the drive rod and alternator. The complete electrical system (alternator, voltage regulator, storage batteries, and cables) may be acquired from an automobile salvage yard as mentioned previously in this chapter. Again, Chrysler Corporation electrical systems seem to provide the highest output for available input torque. Battery output can be connected to the Amateur gear by a short length of heavy wire or cable. Considering I R losses, use of heavy wire is mandatory. One ohm resistance at one ampere of current produces a drop of one volt: A rather excessive amount for solid state gear. Remember to protect batteries and electrical system from direct weather elements and mount the electronics in an enclosure or small "dog house" structure. Try your hand at a small hydro power system for QRP, and it will serve you well during the next long term rainy season.

Cactus and Tomato Power For QRP

Previous discussions in this chapter related to natural power systems for QRO and QRP; now let's talk about some ideas for "big-time milliwatting." There is plenty of room for humorous expansions and personal expression in this area, so let your ingenuity be your guide. Indeed, the traditional Amateur philosophy of "giving the impossible one more try" often surpasses endeavors of cost-effective oriented companies in experimenting with unusual power sources.

Basic electronic theory tells us batteries store energy in chemical form which is converted to electrical energy by use of dissimilar electrodes. The chemical is usually acid based and the electrodes are usually zinc and copper. This arrangement creates a single cell capable of producing .1 to 1.2 volts until the electrodes are "eaten away" by the acid. The group of cells connected in series produces a battery (hence the term "battery of cells"). One of the most well-known electrolytes in batteries is sulfuric acid, but a closer look at ordinary garden vegetables also reveals high acid content. The common garden tomato, for example, is quite high in acidity and might prove interesting as an alternate power source. Assuming a zinc coated wire is inserted in one side of the tomato and a copper plate or wire is inserted in the other side, a small amount of current might be obtained. Series connecting a dozen such

"tomato cells" might thus produce enough energy to power a high microwatt or low milliwatt-rated transmitter. I have had only limited time to pursue this idea, and am thus "passing it on" to you for further investigation. Finally: A worthwhile application for those stout garden tomatoes that take off the roof of your mouth!

Might other plants be useful for "home grown" cells/batteries and milliwatting? Maybe, assuming you have available time for experimenting with unusual items. During a recent television movie of the series "*MacGyver*," for example, the enterprising chap inserted two dissimilar leads in a cactus and used it to power a small transistor radio. Such humoristic science fiction may be scorned by professional engineers, but who's to say it really doesn't work until it has been tried. *After all, there is no law that says Amateur Radio has to be a serious minded pursuit.* Try something unusual. Live a little and have some fun along the way!

I hope you enjoyed this chapter's overview of natural power sources, and encourage you to give one or more of them a try in the near future. As you become aware of bright sunlight, strong winds, and natural waterfalls, you will realize the potential of our many unharnessed energy sources. Keep an open and creative mind, and you will see opportunities for using them are almost unlimited.

73 and Good QRP DXing To You!

We trust you enjoyed reading this book as much as I enjoyed writing it. I heartily encourage you to join the fascinating world of QRP today. If you are a "budding novice," remember to simply combine QRP with your other high power activities. You need plenty of successful high power (100 watt) QSOs to your credit at this most impressionable time. On the other hand, you may elect to simply build a "just for fun" QRP unit to show your friends. More experienced Amateurs: QRP is the supreme challenge and proof of a top notch operator. I am sure you will find the pursuit fascinating, and that it will open many new avenues of enjoyment. Go for it! I also look forward to contacting all of you on the air. I frequent 14.180 -14.225 MHz Sundays between 2230 and 2330 GMT. I also operate 10.101 -10.117 MHz week nights. My mailbag is always overflowing (whew!), and I try to answer those with a self-addressed stamped envelope (please!) as soon as possible. But on-the-air QSOs continue to be the best bet. Good luck to all until we meet on the air, and 73!

Dave, K4TWJ

Index

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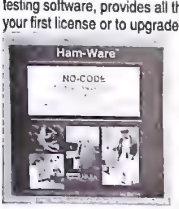

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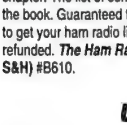

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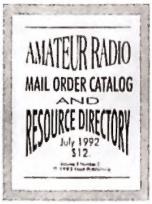

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About the Author. . .

Noted author and CQ magazine columnist, **Dave Ingram, K4TWJ,** is one of the most popularly recognized and respected figures in Amateur Radio today. He has been intensely active in all areas of Amateur Radio for over 25 years and his enthusiasm is irresistibly contagious. Dave has taught college electronics and broadcast engineering, plus he's written over 400 articles and 15 books about Amateur Radio. Dave is well-known for his clear explanations of technical concepts.

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